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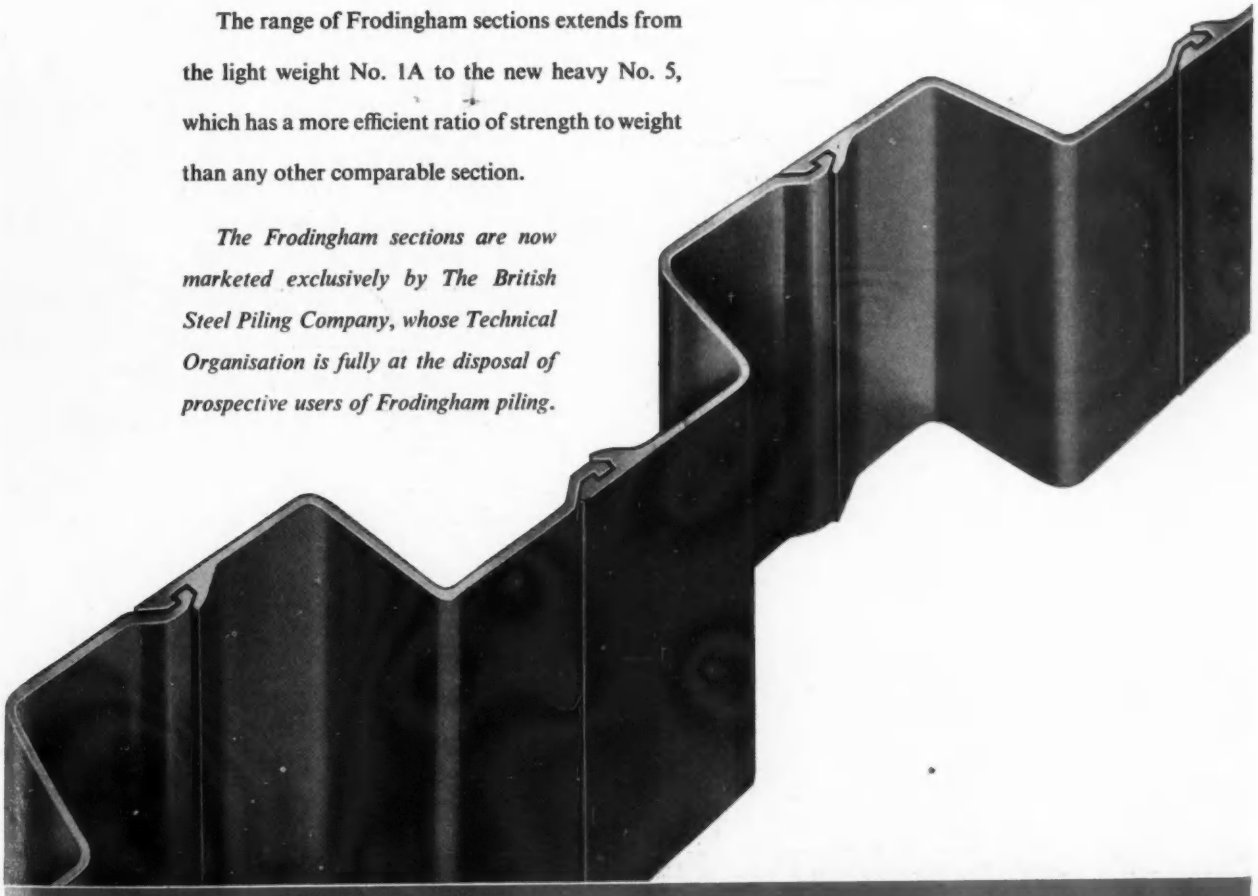

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No. 432

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Editorial Comments

Whitby Fish Quay.

It is perhaps a common, if erroneous, idea that all the really interesting civil engineering projects in the form of piers, wharves, jetties and docks are to be found only at the major ports in the United Kingdom and that little work of any great interest is carried out at the smaller ports and harbours around our coasts. Admittedly the majority of such works are integral parts of the further development of such ports as London, Glasgow, Liverpool and Southampton, to name but a few, but it should not be inferred from this that no works of interest are to be found at our minor ports.

The port of Whitby, on the north-east coast, which is prominent among our smaller fishing harbours, provides a case in point. Just prior to the 1914-1918 war a development scheme of limited size, but of considerable interest, was carried out. This comprised the construction of two independent pier extensions to each of the two main piers with a view to improving conditions within the harbour during heavy weather and, also, the building of an all-timber fish quay abutting one of the harbour masonry walls.

Fish landings are continuous at Whitby throughout the year, and are particularly heavy during the annual herring season in the months of August and September and the facilities which existed prior to the adoption of this scheme were totally inadequate.

Shortly before the 1939-45 war, further developments were undertaken in the inner harbour and the latest project, namely the replacement of the all-timber fish quay by a new structure in steel and reinforced concrete, is the subject of the leading article in this issue. The work includes a number of interesting features, and although the more highly technical aspects of the design and construction have been reserved for a rather more comprehensive treatment of the subject elsewhere, the accompanying article which is illustrated by a number of photographs will, we think, prove of interest not only to civil engineers but also to all those who are associated in a more general way with dock and harbour matters.

The design is in accordance with modern practice for wharves and jetties, and comprises a heavy reinforced concrete deck slab of constant thickness throughout, supported on steel box piles but without any system of substructural bracing. Tidework in construction was therefore to a large extent eliminated, the aim of the designers being speed and economy of construction combined with low maintenance costs. The work also included the stabilising of the adjoining old masonry wall, which had been on the move for many years, and the remedial measures involved are described at some length.

Pneumatic Breakwater Experiments.

It will be recalled that the results of full scale trials carried out by the Japanese Research Committee for Hydrology were briefly reported and commented upon in these columns last July. We have now been informed that a full-scale trial of a new design of pneumatic breakwater, which was recently constructed in the United Kingdom by a private company, has been carried out in deep water at Dover. A substantial reduction of storm waves 6 to 8-ft. high and up to 75-ft. in length was achieved using an air input of approximately one quarter that used in the Japanese trials. Wave reductions of up to fifty per cent. were reached.

The almost total absence of surface currents in these trials indicated that the wave reduction is caused by turbulence and not by counter-currents; in this respect there is agreement between the conclusions drawn from the British and Japanese experiments.

It is expected that further trials will result in a refinement of the new technique and that subsequently, this type of pneumatic breakwater will prove to be an economical method of defeating the adverse action of the waves.

Speeding Up Movement of Export Traffic.

The Ports Efficiency Committee was appointed in March, 1952, to secure the co-operation of all the interests concerned in ensuring a quicker flow through the ports of inwards and outwards cargo. In its third report, published in April of this year, the committee states (paragraph 23):—

" There are many factors which have led to the development of road transport for the conveyance of export goods, but the economic cost involved in keeping a road vehicle waiting to unload is greater than that incurred with a railway wagon, since a road vehicle has to be manned and is itself a prime mover. If a port becomes congested, a rail wagon can more easily be held under load outside the port. A swing back from road to rail transport would materially help to ease the problem and we are glad to learn that British Railways now once more offer a " Green Arrow " service, for full wagon loads of export cargo, which gives a guaranteed date of delivery at the port. We suggest that the reintroduction of this service should be more widely advertised amongst exporters and that they and British Railways should explore the possibilities of small lots being bulked at the larger sending stations in the Midlands and elsewhere so as to make full wagon loads for individual ships."

Following this report, the British Transport Commission have been reviewing their arrangements for the movement of export traffic by rail. Among the measures being introduced are, firstly, the establishment of selected loading depots at Birmingham and other centres in the Midlands for the concentration of export traffic to London and Liverpool and, secondly, the improvement of railway representation at those ports.

A further step has been discussions between British Railways and the Port of London Authority. Early this month, representatives of the British Transport Commission visited the Port of London docks in order to discuss with representatives of the P.L.A., measures for accelerating and intensifying the movement of export traffic to the Port. At the Royal group of docks the arrangements for exchanging railborne traffic to the P.L.A. and the system of handling railborne banana traffic were examined and note was also taken of the improvements made by the Port Authority at Nos. 25 and 27 Sheds, Royal Albert Dock, whereby road traffic can now be handled without causing interference to rail traffic.

The Port Efficiency Committee's emphasis of the need to move more traffic by rail will be appreciated in most dock operating spheres. In certain docks in London, road traffic causes congestion; moreover, since it is difficult to estimate what tonnage of goods will be tendered to each berth each day, it is not always possible to estimate the number of " striking " gangs which will be required. To engage too many gangs is a waste of money and labour; to engage too few results in long waits and lost journeys.

On the other hand, the quantity of goods in railway trucks for each berth can be known in time for the work for the next four-hour period to be planned. Thus, provided the balance does not swing too far the other way (which is most unlikely), an increase in the tonnage of goods tendered by railway wagons would improve efficiency.

Editorial Comments—continued

Methods of Marking Cargo.

The way cargo is marked has a definite effect upon the speeds of unloading ships and clearing goods from transit sheds. There are two reasons for marking: first, to indicate how goods should be handled and secondly to enable them to be identified. As mentioned in our issue last month, the British Standards Institution recently issued a standard recommending a certain procedure for the former, and as far as quick identification is concerned, several organisations are keenly interested in the standardisation of marking for port operating purposes.

Elsewhere in this issue is a short announcement concerning certain proposals put forward by I.C.H.C.A., which represent the views of cargo handlers from a number of member countries, in an endeavour to speed up sorting and tallying. They have been accepted by the International Chamber of Commerce as a basis for discussion with the International Organisation for Standardisation and other appropriate bodies. The International Air Transport Association has also tabled its own handling marks.

This very important matter is therefore beginning to receive the attention which must be given to it is the necessary progress is to be made. The haphazard approaches of the past have never produced satisfactory results.

Timber Handling Conference at Manchester.

A very well organised and successful Conference on Timber Handling was held in Manchester towards the end of last month when some 300 delegates from the timber trade, port authorities, transport interests and manufacturers of mechanical handling machinery met to discuss problems of mutual concern.

Speaking at the inaugural dinner which marked the official opening of the Conference, Mr. Lewis A. Bayman, President of the Timber Trade Federation, said this was the first occasion in their 60 years as a trade association that they had ventured to bring together varied interests for mutual study of a phase of activity. The last few years had seen an increased degree of mechanisation in industry generally, but it had been said—and he believed with some truth—that progress in the timber trade had been comparatively slow. The principal reason for this was due to the fact that timber was a bulky commodity and thus presented unusual difficulties in handling. The time had now come when an interchange of experience and ideas, coupled with demonstrations of the equipment available could not fail to lead to the greater application of mechanical handling in the timber trade. The use of machinery should lead to greater production and the more efficient use of manpower, thus benefiting all concerned.

The subjects for discussion were of great importance to all. To members of the timber trade here and overseas the efficient handling of timber could affect the ultimate cost of the commodity to the consumer, and in order to realise this, one had only to think of the savings it could make in demurrage on wagons and craft, and in the elimination of unnecessary handling.

To the representatives of transport organisations and dock authorities, the subject was of at least equal importance, concerned as they must be in ensuring the speedy turn-round of vessels, the quicker availability of stocks and in keeping down costs. The fact that they were so well represented was evidence, not only that they had these objects well in mind, but also that they were anxious, to improve the services they offered to the timber trade.

The fact that the machine manufacturers considered the Conference worthwhile was shown by their readiness to demonstrate their equipment. He hoped that in imparting their knowledge they would at the same time learn much that would form a basis for developing special, or improved, equipment for timber handling in the future. That was the basic purpose of the Conference—the interchange of ideas and experience to mutual benefit.

In conclusion, the speaker expressed his appreciation of the keen interest and co-operation of the Manchester Ship Canal Company in providing various facilities and making part of their premises available for demonstrations of many different types of mechanical handling machinery and appliances.

The papers discussed during the ensuing meetings were of undoubted interest and showed clearly that there are many problems connected with timber handling which still have to be solved. This is particularly the case where the loading and unloading of timber ships is considered, as it is a matter of direct concern to a large number of port authorities throughout the world. Efficient loading at the export ports would greatly assist expeditious unloading at the end of the voyage and, in view of the importance of the subject, we hope to publish articles on different aspects of the problem in future issues of the Journal.

Problems of the Port Transport Industry.

It is significant that in an article on this subject which appears on a following page in this issue, the author has begun and finished his analysis by referring to the recently published Devlin Report upon the working of the National Dock Labour Scheme. It is significant, too, that much of the article is devoted to the attitude of labour to the industry's problems—although it is stated that responsibility for solving these problems must fall upon port authorities, shipping companies and stevedoring agents, as well as upon the unions.

Since this emphasis has been placed on the domestic relationships inside the industry, it is not surprising that the author has something to say about the method of recruiting dock labourers. " The method of selection of recruits," he rightly states, " has been and still is extremely haphazard " and he makes the recommendation that a would-be docker should serve what is, in fact, a probationary period and that his name should not be added to the permanent register until both employers and unions were satisfied that he was suitable.

It is pertinent to mention here that there is already a change in the qualities required in the potential dock labourer. Although the progress of the mechanisation of the handling of port traffic has been hindered by lack of co-operation on the part of labour, there has been an increasing number of instances where machines have had to be introduced because the packages could not be handled manually. This is particularly so with goods requiring the employment of fork-lift trucks and since it must always be borne in mind that the recruit to the industry is likely to remain with it for 40 years or more, there is no doubt that preference should be given to men willing and able to learn to drive machines. It is true, of course, that many machines are already being used in dock work but some of them, at least, are being driven by men who have learned their new job by empirical methods which have been found to be very expensive.

Thus, although it is obvious that a system of selecting recruits is not only very desirable but urgently necessary, it is also obvious that such recruits should be of the type who will accept, and are likely to become adept in, the new methods of handling which, in the next decade or so, will become more common. This is not an academic suggestion, it is a practical need.

In the problems associated with the employment of dock labourers, the Devlin Report has given no assistance. Employers of dock labour will have to thrust aside their feeling of frustration and with the other interests concerned, tenaciously pursue a progressive policy. As this is done, it will become more and more apparent that the National Dock Labour scheme in its present form is inconsistent with the efficient working of our docks and harbours.

Need to Regularise Employment at Ports.

As we go to press, an important contribution to the subject of dock labour relations was made this week by Mr. Francis H. Cave, general manager of the Mersey Docks and Harbour Board, when he delivered his presidential address to the Institute of Transport in London. The title of his paper was " The State of the Ports," and after briefly reviewing the progress made since the war in the physical reconstruction and rehabilitation of U.K. ports, he called attention to the problem of dock labour unrest. He pointed out that the man-days lost through disputes at the docks were far greater than in any other industry, and as a result there have been four official enquiries within the last eight years. He suggested that one way to change this unhappy state of affairs would be to replace the present system of engaging casual labour by a system based on regular employment.

This suggestion is undoubtedly controversial, and it will be interesting to learn the reactions of all the interested parties—particularly the port employers. However, in view of his life-long experience of the industry, Mr. Cave can claim to speak with some authority; his remarks therefore merit careful attention.

Reconstruction of Fish Quay at Whitby

Replacement of Timber Structure by Steel Piling

By G. W. ROOKE, M.I.C.E.

THE Port of Whitby, which stands at the mouth of the River Esk, dates back to pre-Norman Conquest times, and at one period ranked high among the ports of the Kingdom. Its present importance lies mainly in its close proximity to good fishing grounds, and it is also one of the ports of call for the Scottish herring fleets during the months of August and September when fish landings are particularly heavy. Throughout the year the local fleet supplies a healthy fishing industry.

At first mention of its name, Whitby may perhaps be regarded as having an eastern, or at any rate a north-eastern aspect, since it is situated on the east coast. In actual fact, that part of the coast on which the town is sited runs nearly east to west, and the harbour in consequence faces due north. It is therefore exposed to the full force of northerly gales with an uninterrupted fetch from the Arctic regions. In consequence the form of the east and west piers which protect the harbour has been subject to considerable modifications and extensions from time to time in attempts to improve berthing conditions within the harbour.

The last of these modifications carried out prior to the 1914-18 War seems to have substantially improved matters, but nevertheless, in any project involving the reconstruction of berthage inside the harbour, the possible effects of such reconstruction upon berthing conditions must be taken into account when deciding upon the design of the new work.

The Fish Quay, which is the subject of this article, is an entirely new structure superseding the earlier all-timber quay constructed nearly 50 years ago. It abuts over its entire length the old masonry harbour wall constructed between the years 1786-1789 which is in southward continuation of the root of the West Pier, the junction between the two being marked by a masonry spur projecting some 60-ft. from the face of the harbour wall and known locally as Scotch Head.

So far as can be determined from old records and photographs the harbour bed level at the face of this old wall stood at about half tide level, that is, about 13-ft. below the mean height with the top of the wall which, containing as it does Pier Road, falls with the gradient of that road from Scotch Head at the north end of the site of the quay to about 290-ft. from its southern extremity, after which it continues southwards at a constant level. Mention has, however, been made in some old chronicles of the shore having built itself up to such a height that small boys could jump on to the sand from the top of the wall. At such times its depth below the top of the wall must have been considerably less than the figure above mentioned.

The base of the wall appears to have been between 6 and 7-ft. below the shore level above defined, and under such conditions there would not appear to be any reason why it should have been in any respect unstable. It was obviously a well built structure in squared masonry blockwork, but with dry joints.

The author's firm made their first official acquaintance with this site in 1947, when they were asked to examine and report on the condition of the Fish Quay, and to make recommendations as to the form and extent of such remedial measures as they considered necessary. Following the requisite inspections and the sinking of a small number of boreholes a report was submitted early in 1948 to the Harbour Authorities.

Fig. 1. Demolition of old decking in progress.

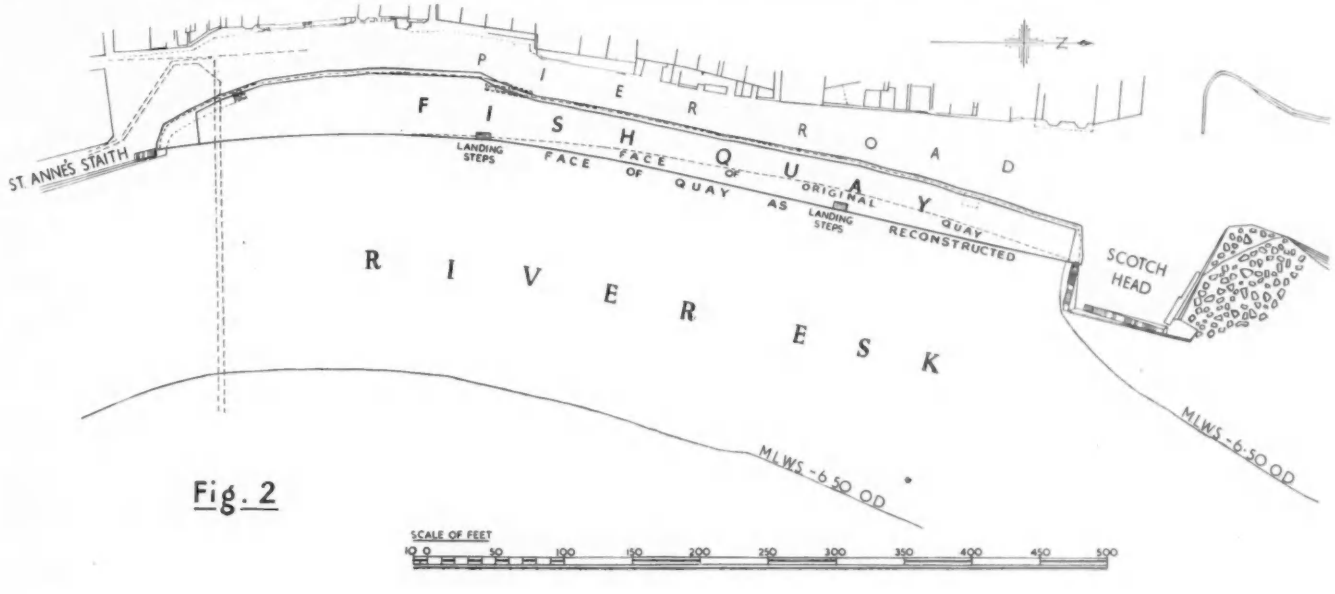


Fig. 2

Reconstruction of Fish Quay at Whitby—continued

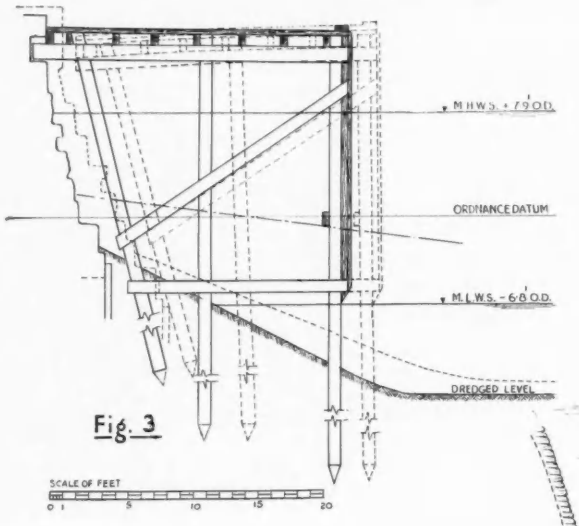


Fig. 3

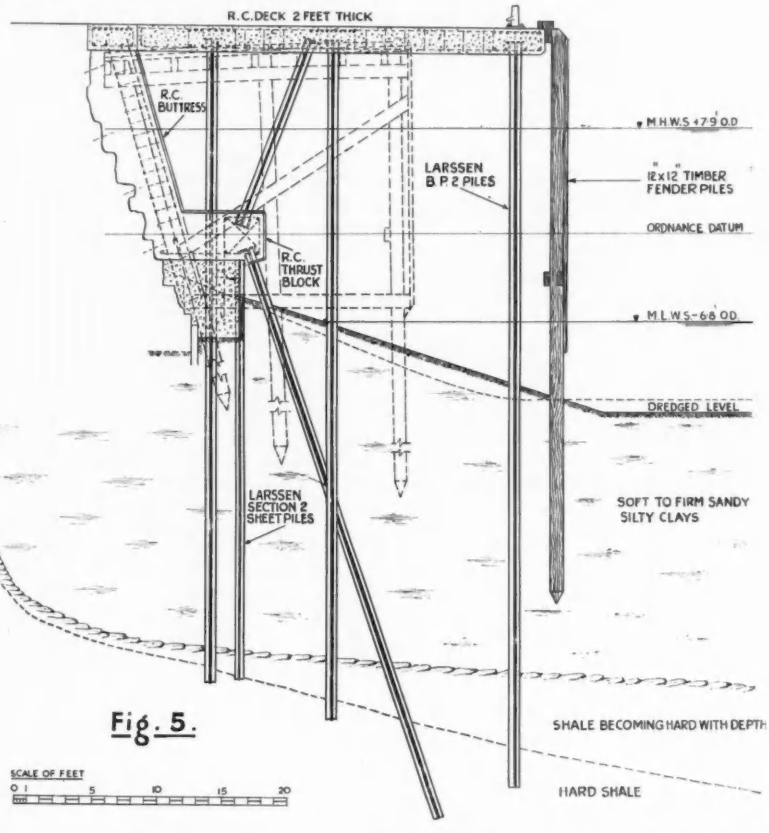


Fig. 5.

A supplementary report was submitted in September, 1948, following some test loading of the decking, which recommended that over that portion of the length where the old masonry wall had been, and still was, on the move the connections which had up to that time existed between the quay and the wall, should be severed.

This recommendation was carried out some time later, but nothing further of any substance resulted from either of these reports owing to financial considerations.

Following the great Storm Surge at the end of January, 1953, the firm were again called in to inspect the structure with a view to assessing the extent of the damage caused to it on that occasion. By that time the condition of the structure had further deteriorated and it was evident that substantial reconstruction could not be long delayed without risk of serious mishap.

Following further negotiations, and contact with the then Ministry of Agriculture and Fisheries, instructions were received from the Harbour Authority in October, 1953, to prepare a further report and to submit recommendations for the entire replacement of the existing structure and the stabilising of the old harbour wall.

Further borings were carried out by Messrs. Soil Mechanics Limited and a report was submitted to the Clients in June, 1954, recommending replacement of the timber quay in open construction with steel piles supporting a reinforced concrete deck.

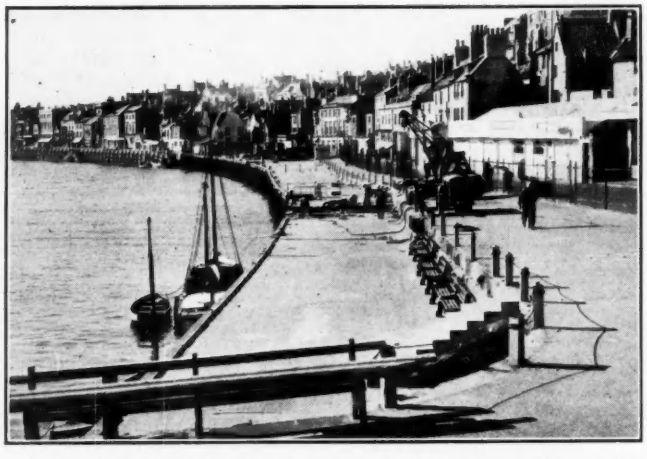


Fig. 4. View of quay taken at commencement of reconstruction works.

Locally there had been a strong desire that the reconstruction should take the form of a steel sheet piled and anchored retaining wall backfilled and extending from the south-west corner of Scotch Head to the point where the old masonry wall curves round to meet the adjoining old wall of St. Anne's Staith immediately to the south. This was perhaps only natural as it would have given a very considerable measure of widening to the area in front of the shops, amusement palaces and other buildings. It was, however, for various reasons considered liable to involve serious risk of a deterioration in berthing conditions alongside during heavy weather and after further discussions the recommendations in the report were finally accepted.

Instructions were received in September, 1954, to prepare a Contract for the complete reconstruction of the quay as existing and also for the stabilising of the old masonry wall, with an alternative on the same lines but to embody a limited degree of widening so as to increase the total width available over the narrowest portion of the area in front of the shops. In order to gain the full benefits of this widening it was further decided that the level of the quay should follow the gradient of Pier Road hitherto described.

Contract Documents and Drawings were prepared in accordance with these instructions, and in January, 1955, invitations to tender were issued to a large number of well known firms highly experienced in this kind of work. The tendering was remarkably keen and the Contract was awarded in March of that year for the reconstruction together with the limited degree of widening, to Messrs. J. G. Thompson & Sons (Contractors) Ltd., of South Shields.

At the north end of the site the harbour bed and wall foundation comprise hard shale standing at about the level of Mean Low Water of Spring Tides. At a distance of about 150-ft. from the north end the rock falls steeply to a very much lower level and is overlain by miscellaneous deposits consisting generally of soft clay, ballast and sand. These conditions continue southwards over the remainder of the length of the quay.

The design of the original quay was as already stated in timber

Reconstruction of Fish Quay at Whitby—continued

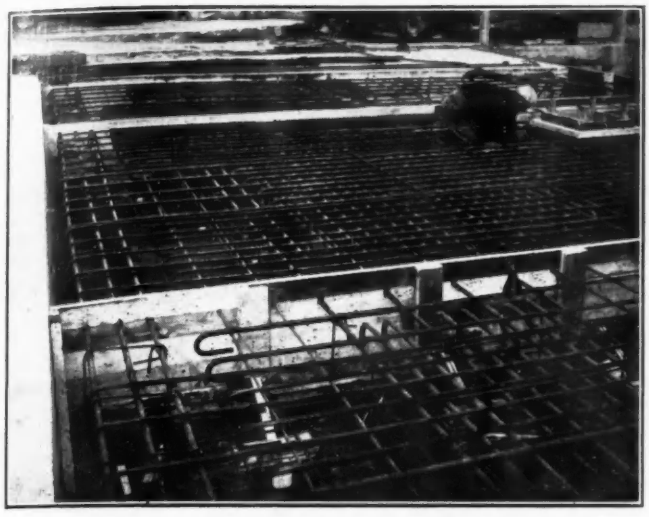


Fig. 6. Deck slab reinforcement being placed.

throughout, with 12-in. x 12-in. piles, 14-in. x 7-in. transoms in pairs one on either side of the piles, and 12-in. x 6-in. longitudinal bearers, all of creosoted pitch pine, and with a 4-in. thickness of uncreosoted pitch pine deck planking.

About the year 1934, however, the planking had decayed to such an extent that it had, over a portion of the deck area, been covered—and over the remainder replaced—by a 4½-in. thickness of reinforced concrete.

The quay was designed for a dredged depth of 7-ft. at Mean Low Water of Spring Tides, that is 28-ft. below deck level, which was constant throughout its entire length and which therefore did not follow the gradient of Pier Road, being lower than it by progressively increasing amounts from a point 290-ft. from the south end, to Scotch Head where the difference in level was as much as 5-ft. 6-in., as will be seen from the photograph (Fig. 1), which, looking northwards, shows the demolition of the old decking in progress.

The alignment of the face of the quay is clearly shown in Fig. 2, from which it will be apparent that it was very narrow over most of the centre portion where the wall foundation was poorest, and the designed depth above referred meant that the upward slope of the ground from the face of the quay inwards to the wall did not, being of soft consistency and therefore unable to maintain a steep slope, strike the wall itself much more than a couple of feet above its base as indicated in full lines in Fig. 3.

Practically the whole of the supporting material in front of the old wall hitherto affording it adequate stability was thus removed by the dredging, and both lateral and downward movement was therefore to be expected and did in fact occur, progressively increasing over the succeeding years.

In the construction of the quay the transoms were made of sufficient length for their inner ends to extend into the upper portion of the old masonry wall for a few feet.

It has been confirmed from an old photograph that the face of the quay was aligned accurately to a true curve, whilst another photograph taken at the commencement of the Contract (Fig. 4) shows a definite flat of considerable length over the centre portion of the quay.

It therefore, all things considered, seems reasonable to assume that the movement of the wall, and of the quay which was anchored into it, commenced shortly after the berth was dredged to its designed depth.

Owing to the absence of records it is difficult to estimate precisely the extent of the movement of the two structures, but after a careful study of all the information available it would appear that the wall has settled over the years since it was built by an amount slightly exceeding 3-ft., and that its head and the quay to which it was attached has moved forward at least 2-ft., and perhaps rather more. Both these figures refer, of course, to the point of maximum movement situated at about 300-ft. from the north end, the above amounts reducing progressively to nothing reckoned up to distances of about 120-ft. north and 60-ft. south of the above point.

The quay, which, as already stated was up to the end of 1948 connected to the wall over its entire length, had, by the beginning of 1953, moved forward with the wall nearly 2-ft. and had dropped in level at the point of maximum settlement of the wall about 1-ft. where it abutted the wall, whilst at the berthing face it had, up to the date of its demolition, generally maintained its original level. This is illustrated by the quay outline shown in broken lines in the cross section in Fig. 3.

This settlement of the inner portion of the quay was clearly due to the upper courses of the wall becoming wholly supported on the projecting ends of the transoms as the wall settled, thereby severely deflecting them—in one or two cases practically to the point of fracture—and forcing the inner line of piles to which they were connected, and which were of very limited penetration, further into the ground.

When designing the reconstruction it soon became clear that the function of stabilising the wall against further movement called for the reinstatement in one form or another of sufficient of the stabilising forces eliminated when the filling in front of the wall was removed by dredging to the original designed depth.

A typical cross section of the quay as reconstructed with, in broken lines, the profile of the old timber structure as it stood at the commencement of the Contract, is shown in Fig. 5. This section is taken at the point of maximum movement, and illustrates the form of the stabilising measures. For the northern portion of the quay the construction is very similar, but here, as for the southern portion, no stabilising measures were necessary and such lateral strength as was called for was provided by means of raking piles driven at intervals, similar provision being included over the southern portion of the quay though here, where its width is generally very much greater, additional vertical bearing piles were also necessary in the pile bents.

In contrast to the original structure the level of the new quay was, as already stated, increased progressively from a point 290-ft. from the south end to follow the mean gradient of Pier Road up to the northern end at Scotch Head. This has the great advantage of enabling lorries to approach the quay at any point within its length, whereas previously this was only possible over the southernmost 290-ft. The resulting longitudinal gradient of the quay does not appear to have any serious disadvantage.

The face of the quay as widened is shown by a full line in Fig. 2. The main features of the new construction comprise a 2-ft. thick heavy type reinforced concrete deck slab supported on steel box piles of Larssen Section BP.2 in bents at 15-ft. centres longitudi-

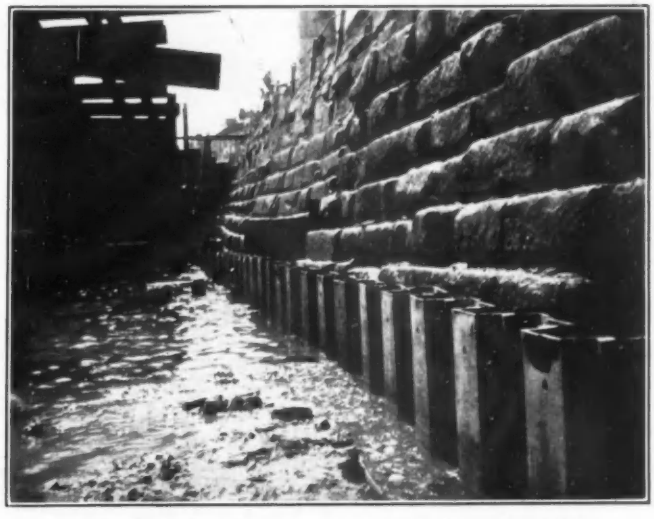


Fig. 7. Steel sheet piling in wall strengthening, after driving.

Reconstruction of Fish Quay at Whitby—continued

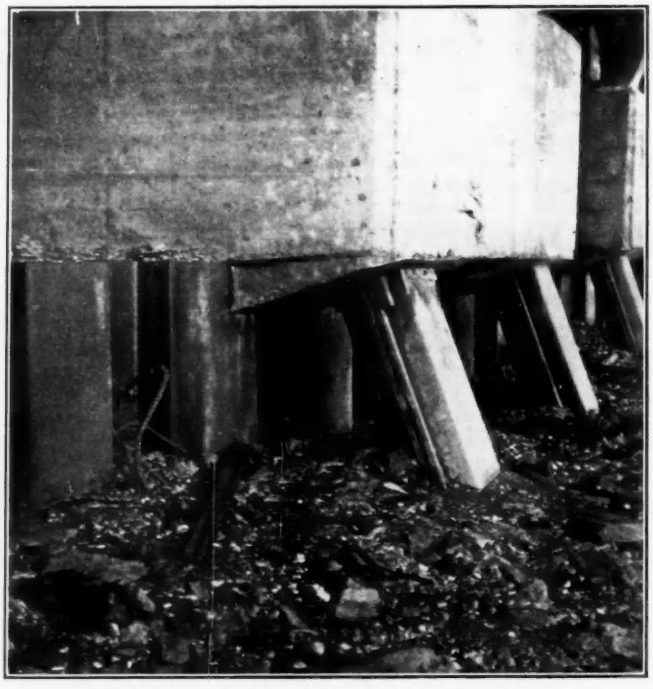


Fig. 8. View of lateral support to the heads of sheet piles.

nally with 12-in. x 12-in. incised and creosoted Douglas Fir fender piles at 7-ft. 6-in. centres.

The decking is designed to carry the Ministry of Transport Loading for Highway Bridges since it will be subjected to the heaviest lorry loadings during a certain period of the year. Part of the reinforcement in position is shown in Fig. 6.

This loading involves axial pile loads up to a maximum of 60 tons and it was considered that the Larssen BP.2 pile would be adequate to stand up to the severe driving necessary to ensure the normal margin of safety above that figure.

It was realised that difficulty might be encountered in driving through boulders known to exist over the centre and southern portions of the quay. The final set specified was not more than 1-in. to 20 consecutive blows with a 2-ton semi-automatic hammer freely falling 3-ft., or equivalent, and in the case of it being attained at a level which was obviously above that of the hard stratum, driving was specified to be continued within practical limits until the resistance provided by the obstruction was overcome and the specified set was obtained in the hard shale.

The BP.2 piles were supplied with open ends and were not fitted with shoes since it was felt that this would facilitate not only the overcoming of obstructions within the centre and southern portions of the quay, but also the driving of the piles over the northern portion where the hard shale stands at about the level of Mean Low Water of Spring Tides. The piles fulfilled everything that was required of them and indeed exceeded expectations at the north end where they drove generally to penetrations of up to 15-ft. into the hard shale without any special difficulty and, thanks in no small degree to the care taken in driving, with little or no damage to their heads.

The piles over the centre and southern portions were driven generally to penetrations of the order of 30-ft., but much greater penetrations up to and exceeding 40-ft. were by no means exceptional. Again thanks to careful driving, boulders and other obstructions were overcome without damage to the piles, and in nearly every case without any noticeable departure from the vertical. Raking piles were driven with similar care and accuracy. Pile lengths varied between 40-ft. and 65-ft.

The quay is fendered with 12-in. x 12-in. x 40—45-ft. incised and creosoted Douglas Fir piles driven to about 11-ft. below dredged level except at the north end, where a penetration into the hard shale of the order of 6-ft. could seldom be exceeded. The pile heads are fixed to a continuous 12-in. x 6-in. timber plate anchored to the front face of the deck slab and the piles are interconnected at about 5-ft. above M.L.W.S. with a compound timber waling designed both to spread a normal blow on one pile to those on either side and also to distribute an end-on blow on any one fender to those immediately following. This waling consisted of a continuous half-timber bolted to the backs of the piles and also bolted, through half-timber packings which in places formed its splice plates, to short lengths of fitted half-timber struts running between the side faces of the piles. This arrangement considerably increased the strength in bending above that which would have been obtained if the rear timber had not been bolted to the struts.

A half-timber coaming laid flat and with outer arris rounded is provided along the outer face of the deck slab with a smaller timber abutting on its landward side and recessed to house the 1-in. dia. water main, branches being led into holes cut in the larger timber to house the connections and covered by a galvanised plate. Bean type III bollards are fitted generally at about 25-ft. centres and anchored with 6 No. 1¼-in. dia. holding down bolts taken 15-in. into the depth of the deck slab with suitable anchorage at their lower ends. Access ladders are provided in the face of the quay at about 100-ft. intervals, with two sets of landing steps.

The decking at each end is finished with an independent slab connected to Scotch Head at the north end and to the old wall at the south end. Expansion joints 1½-in. wide were formed between these two end bays and the deck slab proper to allow for the expansion and contraction towards each end from the centre. Similarly there is an expansion joint with chamfered arris filled with "Inertol" sealer between the rear face of the deck slab and the new concrete works abutting the quay along its landward limits.

These works comprise in places the bringing forward and rebuilding of the upper courses of the wall as necessary to limit the length of the cantilever portion of the deck slab beyond the innermost vertical bearing pile, and in other places a 2-ft. thick reinforced concrete beam similar to the deck slab and spanning

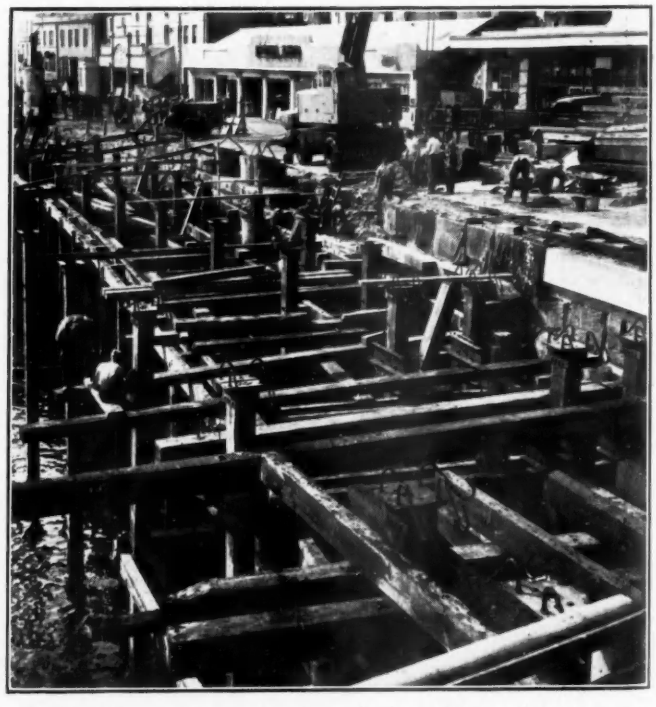


Fig. 9. View of the new steel box piles in position at the north end of the quay. Also of short length of concrete capping stone. Note also the channel cleats on piles for supporting 12-in. x 12-in. timber beam for deck shuttering.

Reconstruction of Fish Quay at Whitby—continued

longitudinally between buttresses supported either on the low level wall stabilising over the centre portion, or on the old boat landing at the south end.

The wall stabilising — 250-ft. in extent — comprises a line of Larssen Section 2 steel sheet piles driven into the hard shale, and therefore varying in length between 20-ft. and 35-ft., in front of the toe of the wall, the volume between the piles and the wall itself being filled with concrete and therefore providing a deep new toe as a seal against any chance of the material under the toe flowing outwards and upwards. A portion of this steel sheet piling taken immediately after driving is shown in Fig. 7.

Lateral support to the heads of the sheet piles is provided by twin Larssen Section BP.2 piles in pairs at 15-ft. intervals, one such pile being driven 3-ft. on either side of the pile bents to a rake of 1 in 3 and penetrating well into the hard shale in order to develop a safe bearing load of 60 tons. These piles can be seen in the photograph (Fig. 8). The inner bearing piles of the bents thus pass between the piles of each pair of rakers, and behind the sheet piling and through the concrete filling. A reinforced concrete thrust block bonds each pair of rakers to the sheet piling and concrete filling, and also to the vertical piles.

It is estimated that by this means adequate support will be available to resist any future tendency of the wall to move forward.

Over the length of the stabilising raking bracings made up of Section BP.2 Larssen piling are provided from the decking just behind the middle line of bearing piles down into the thrust blocks above mentioned, and elsewhere stiffening is provided by means of a BP.2 pile driven at a rake of 1 in 3 beside every alternate pile bent.

The pile heads after driving and before incorporation in the deck slab were fitted with $\frac{7}{8}$-in. thick steel capping plates bolted to the heads of the piles by means of angle cleats, it being found that the necessary bearing for a load of as much as 60 tons could not by orthodox methods of design be obtained by any more suitable method. Fig. 9 illustrates this arrangement and shows the pile driving advancing from the north end.

The pile extensions, of which there were 31 of varying lengths up to a maximum of 14-ft., were connected to the piles by means of $\frac{1}{2}$-in. thick cover plates welded externally.

The shuttering of the deck slab was of necessity heavy. Where practicable the existing structure was used to provide a bearing for the primary supporting members, but more generally the shuttering was supported wholly on the new steel piles after driving.

In order to support the transverse bearers two pairs of twin channel crossheads were placed in direct contact one above the other, and fixed near the heads of the steel box piles with through and clamp bolts. The transverse and longitudinal supporting timbers were of heavy section.

The soffit shutter itself consisted of units each about 6-ft. x 3-ft. of 2-in. tongued and grooved boarding. These provided a most satisfactory form of shuttering. The soffit shutter in position is illustrated in Fig. 10.

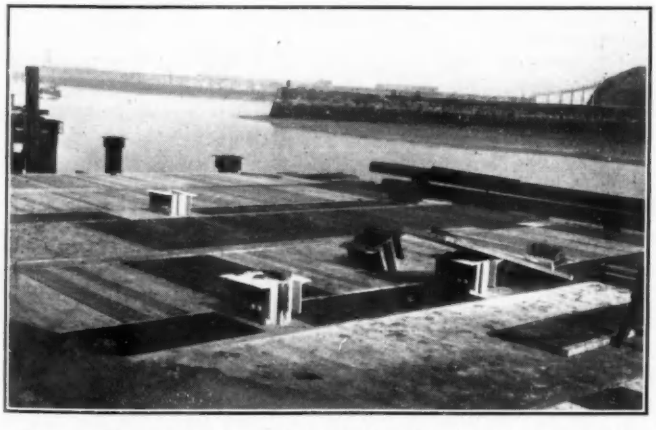


Fig. 10. The wooden "pans" in position forming the floor of the deck slab.

Fig. 11. General view of the new quay nearing completion.

The concrete mix for the deck slab was a nominal 1 : 2 : 4 made with Ordinary Portland Cement and with graded aggregate, the sizes of the fine being up to $\frac{1}{8}$-in. and those of the coarse between 3/16-in. and $\frac{3}{4}$-in. The mix was placed very dry with slumps generally of the order of $\frac{1}{2}$-in., and to obtain the necessary consolidation with such a dry mix, immersion vibrators operated by compressed air were used. These were operated with skill and had no difficulty whatsoever in bringing the mix up to the necessary consistency. The rate of concreting, slow at first, was progressively speeded up and later 40 cubic yard bays fed by crane-operated skip from one batching plant and by monorail from a second, were concreted in 4 hours.

The surface of the quay was given a smooth screeded finish to a slope of 1 in 80 towards its outer face, where drainage holes were provided through the deck slab behind the coaming timber at intervals of 3-ft. 6-in. longitudinally.

The mix for the concrete in the sheet piled toe over the extent of the wall stabilising was increased to 1 : $1\frac{1}{4}$: 3 as it was anticipated that some of this might have to be placed below water, or at least that the tide might wash some of the cement away on its return. In actual fact most of the concrete was placed in the dry and there was very little sign of any leakage of cement through the sheet piling. A similar mix was used for the reinforced concrete thrust blocks.

The reinforcement for the transverse beams consisted at the points of maximum moment of a number of 1-in. diameter bars within the width of the concealed beams, which was taken as 4-ft., with a smaller number of similar bars in the longitudinal beams which were designed on a width of 3-ft. 6-in. The slab panels were reinforced with $\frac{1}{2}$-in. dia. bars top and bottom in both directions.

A general view of the New Quay nearing completion is shown in Fig. 11.

The Works were designed for the Whitby Urban District Council by their Consulting Engineers, Messrs. Lewis and Duvivier, MM.I.C.E., and the Contract was, as already stated, carried out by Messrs. J. G. Thompson & Sons (Contractors) Ltd., of South Shields. The Resident Engineer was Mr. S. M. Johnson, O.B.E., M.C., M.I.C.E.

Los Angeles Oil Terminal Modernised.

It was recently announced that the port of Los Angeles has completed a modernisation programme to its maritime oil terminal at a cost of $2,250,000. The Union Oil Company of California's operations at the harbour have practically doubled as a result. Among the additions to the oil company's facilities is a new 600-ft. concrete wharf. With the previous wharf, this now permits two large tankers to dock simultaneously.

Problems of the Port Transport Industry

Need for New Ideas and a Constructive Policy

By "ONLOOKER"

THE Report of the Committee under Mr. Justice Devlin, appointed by the Government to inquire into the Dock Workers (Regulations of Employment) Scheme, will be a sore disappointment to many, and not only employers. They believed, and had been confirmed in their belief by previous investigations, that certain elements in the Scheme constitute a factor contributing to the unease in the industry, and had hoped that an inquiry of this high character would dare to grasp the nettle and, while not necessarily accepting the recommendations of interested parties, would at least make some positive recommendations of its own. Instead, the Report demolishes the proposals of the employers, who had recommended major changes, and pronounces some moral exhortations in their stead.

The Attitude of the Public.

At no time in its long history has public interest been so much directed to the docks industry as in recent years. It is noteworthy that the public attitude has been increasingly unsympathetic towards both management and labour. The public is naturally disinclined to be sorry for management, in any field; after all, its function is to run its business smoothly and efficiently, and if for any reason it should fail to do so, it will quite properly be held culpable. The lack of sympathy with labour, however, is more significant, for it means that the public attitude has changed. It is not so long since dock labour unrest was assumed to be a natural reaction against harsh and degrading conditions of employment. The public now knows that the working conditions, while by no means perfect, have been vastly improved, and in many respects compare favourably with those in similar industries.

That the public should be greatly concerned with the industry is only to be expected. Obviously an island economy is dependent on sea transport, and with the growing realisation of the vital importance to the country of international trade, the public is becoming sensitive to disruptive phenomena. The most manifest kind of disruption will be at the sending and receiving ends, that is to say, in the ports.

It is not merely natural, but right, that the community, from motives of self-interest, should keep a watchful eye on this essential department of national activity, and should condemn any failures. This view is not always accepted by those in the industry itself, who are apt to resent the publicity given to their shortcomings; but perilously poised as the national economy is, the day is rapidly passing when the running of a vital industry can be regarded as purely the private affair of the employers and workers. The public increasingly insists that the first duty of an industry is to serve the community, and that the community should be able to criticise its operation—which is by no means to say that the public wishes to control it.

The Attitude of the Press.

The press has partly reflected this public anxiety in regard to the docks industry, and partly it has created it. A small strike, especially in London, is given a degree of prominence out of all proportion to that given to strikes of equal size in other industries. Trouble in the docks is news. And the troubles therefore achieve such notoriety that unofficial investigators find the industry a fruitful field for research and theories.

This is not the only reason for public interest. The dock employers themselves have since the war deliberately followed a policy of examining and exposing what they consider to be defects, with a view to their being remedied. They have done so to a far greater extent than employers in other industries, some of which suffer equally from restrictive practices of one kind or another. The dock employers should not be condemned—although in fact they sometimes are—because the remedies they have proposed are of their own devising. At worst they have shown courage in challenging what they consider to be evils. And here it is worth noting that the employers are not simply a set of private business men engrossed in their selfish interests; they cover a wide variety of undertakings, including public trusts.

That there are things wrong, whether in the ranks of management or labour, can hardly be denied. How else explain the repeated stoppages, the host of official and unofficial inquiries since the war into turn-round, into port efficiency, into mechanisation, into strikes, and into the Dock Labour Scheme?

It is no answer to say that there are also things—many more things—right; but there is a danger that, with all the adverse publicity, this may be overlooked. Many employers will admit privately—and sometimes publicly—that the standard of output has improved very considerably from the low levels to which, for various reasons, it sank during and immediately after the war. Sweeping condemnations of turn-round often reflect lack of knowledge of the factors involved. The favourite approach is to compare post-war and pre-war figures. Pre-war and post-war conditions are so different, as regards cargoes, berthage, ships, equipment and labour organisation, that such comparisons would be invalid even if adequate data existed, which they seldom do. (Even to-day there is a reluctance to publish statistics of turn-round, the argument being that there are so many variable factors involved that it would be dangerous to draw conclusions from them).

That turn-round is in many instances unsatisfactory is, of course, abundantly clear, and much can be done to improve it. It may be that war damage in British ports was not tackled anything like so quickly and comprehensively as it should have been, with the result that ports which suffered more severely on the Continent are now better equipped. It may be that the standards of management in the industry have deteriorated, and in particular that supervision on the dock-side is not so effective as it used to be. It may be that labour does not work so well as before the war, even with the incentive of piece-work and better gear, and that the over-security (as is said) of the Dock Labour Scheme is primarily to blame. (Even so, anyone who considers that labour shortcomings are entirely a post-war product, should glance at the evidence given to the Shaw Inquiry in 1920.)

Similarly it is difficult to make comparisons between this and other countries. The docker in the United States, although he seldom does piece-work, is casually engaged, and has thus the same incentive to hard work (the desire to ensure future employment) as the docker in Britain before the war.

The hours of work are being more restricted in Britain than on the Continent, shift-work being the exception and not the rule; but it does not follow that output per man is any better on the Continent. In any case, there is little point in shift-work unless the other forms of transport which serve the docks are prepared to be equally accommodating.

The rates of output are largely governed by the degree of mechanisation, and here there is undoubtedly a greater conservatism in Britain than on the Continent or in the United States. Yet there are notable developments. On the north-east coast of England, and in South Wales. For instance, the discharge of iron-ore has been mechanised to the point where prodigious outputs are achieved.

The Attitude of the Dock Workers.

To carry this last point a little further, mechanisation is by no means so lacking in British ports as is often suggested. As with all things British, the process is generally one of evolution rather than of innovation. Labour, for obvious reasons, and particularly the

Problems of the Port Transport Industry—continued

fear of redundancy, is chary of new methods—and new methods are not necessarily the same as new machines. Employers too are hardly revolutionary in their approach; often they have an established trade, which suffices them and which they handle with reasonable dispatch; new machines are expensive and their introduction a delicate matter so far as labour is concerned; and a speedier turn-round may mean on the docks a slack in labour and machine-time which cannot be profitably taken up by new traffic.

Labour is not always so unco-operative as is sometimes made to appear. The fact is that the introduction of labour-saving methods is an extremely explosive matter which must be handled delicately, almost privately. For instance, the introduction by one firm of a few fork-lift trucks could easily become an issue of national significance, involving questions of redundancy and even of pensions for retiring men. The consultations with labour on new methods (which are required by national and local docks agreements) are therefore often pursued with a minimum of fuss. The degree of success varies, and much depends on local atmosphere. Methods have been introduced in, for instance, Bristol, which would probably create a furore in London or Liverpool.

The Attitude of the Employers.

It can, of course, be held that it is the duty of management to insist on improved methods even if they do provoke opposition. Management does not escape criticism in this and other directions. The output in the docks could be enormously increased if men only worked, not harder, but the prescribed hours. Bad time-keeping in various forms is a feature of the industry, and part of the blame must inevitably be laid at the employers' door. Some employers will admit—privately—that they do not object to men taking time off unofficially, because (they say) with piece-work they will make up the loss by increased effort. It is a dubious argument in more ways than one. There is, however, no doubt that many employers individually countenance such practices, and although their organisations, and even those of the workers, may condemn them, it is not so easy to take effective action. Some of the malpractices are now well established, and to eliminate them it is not enough to make a stand or to issue warnings; it requires a sustained effort on the part of foremen backed to the full by management. And both foremen, enjoying as they say only a precarious authority as best, and top-management, anxious not to precipitate the serious trouble which a challenge to long-standing practices would certainly involve, tend to wink an eye. One weak link among employers is enough to defeat a campaign, especially under a system where men are drawn from a common "pool," and may even (in some ports) up to a point choose their employer. The Unions say that good time-keeping and such are matters for management: but they could do a great deal more in instilling the need for observance of industrial agreements into their members, and in giving positive backing to reforming measures. Apart from their responsibilities as Trade Unions, in the docks industry they now have a direct (joint) responsibility under the Scheme for the effective use and deployment of the labour force.

The Attitude of the Shipping Companies.

Management's fear of trouble is real and understandable. Shipping is an extremely vulnerable industry, and the ship-owner, as the stevedoring contractor's major client, ultimately calls the tune.

While shipping interests are obviously concerned with the loading and unloading of their vessels, their interest in the operations may be direct or indirect; that is, they may control a stevedoring enterprise on their own behalf, or they may employ stevedoring contractors. In either case they may or may not take an active part on the bodies which legislate for the stevedoring industry. It is highly desirable that they should play such a part, and it is unfortunate that there are important shipping companies which tend to look on dock affairs as a necessary nuisance. It is good for the industry to have shipping interests playing a direct part in its counsels, and it is equally (if not more) to the benefit of ship-owners, for thus the parties are made aware of their respective problems and their common needs. Instead of looking on stevedoring and other dock contractors, and even port authorities, as of secondary importance, and as the poor relations of shipping, ship-owners should look on the port transport industry as the equal partner of sea transport. Docks would be of no value without ships to use them, but the reverse also applies. Broadly, the same motives, neither more nor less altruistic, actuate all the parties, that is (as a ship-owner recently stated in regard to his own company) to provide a service and make profits.

Above all, the shipping interests should support the dock employers' organisations in their policies, in the framing of which they should have played a part. It is not unheard of for the ship-owner to agree or even insist on giving way to unreasonable demands on the part of labour, because of the fear of his ships being held up. The contractor in turn is often only too anxious to make a settlement which will avoid any hold-up. Both hope that such a clandestine settlement will not be held to establish a precedent; in fact, the industry is riddled with bad case-law.

It is only fair to say, however, that, taking the Industry as a whole, management has shown quite surprising unanimity and firmness on major issues—sometimes extremely contentious issues, such as the question last year of the recognition outside London of the Stevedores' Union—even at the expense of serious stoppages. The remarkable thing is not the occasional defection, but the solidarity of ship-owners, port authorities, contractors, etc., in defence of what they regard as principles.

The port authority may do the whole or part of the stevedoring, as in Manchester, London or Bristol. It is sometimes suggested, but significantly enough, seldom by ship-owners, that the port authority should in all cases have the monopoly. Shipping interests do not favour monopoly in the ports, and were foremost among the opponents of the proposed extension of the Transport Commission's sway under the first Transport Act. There are obvious advantages in single control, and a single employer of labour, as there are in any industry, but there is also much to be said, from the consumer's point of view, for the flexibility of a system which has grown out of competition for particular services —and port transport is a many-sided activity. Probably the main argument for the port authority taking part in stevedoring, is that it is better equipped, generally speaking, in capital resources and management skills.

This suggests that the fault is not with private employers as such, but in there being too many of them. As with labour, so with employers, it was in the past too easy to enter the industry. It is now becoming more difficult, partly because in most ports there is, in effect, by tacit understanding a "closed shop" for employers, and a disinclination to trespass on each other's preserves. Again, the National Dock Labour Board wisely insists that an applicant for registration as an employer must furnish certain financial guarantees, which acts as a deterrent to the unqualified. It is, in fact, difficult to start a new undertaking in a port, except perhaps with a new traffic. Not so long ago, dockers themselves started a stevedoring contractor's business in one port, but it seems to have made little headway, although in theory it might seem to have many initial advantages.

There is little doubt that the number of employers in the ports, notably in the large ones, is too great. Available traffic would be better handled with fewer firms. The elimination of certain smaller ones, with little stake in the industry, would remedy a source of friction between employer and employer, and between employers and labour. A measure of internal rationalisation would certainly be benficial, and there is some evidence that the process is going on, although slowly.

So far as the Dock Labour Scheme is concerned, this has been so thoroughly investigated that it is now a case of agreeing or disagreeing with the findings of the investigaters. The latest, the Devlin Report, adds little to our knowledge: indeed it can be held to subtract, for it refuses to endorse the conclusions of the previous most authoritative investigation under Sir Frederick Leggett (an acknowledged expert in all labour matters). It even refuses to support the minor administrative improvements the industry itself had already worked out. It seems to reflect a suspicion of employers as such; not only of their proposals, but even of their motives. And it is notable that of all the proposals tabled by the employers, the only one accepted is a system of penalties for employers themselves.

Problems of the Port Transport Industry—continued

The Attitude of the Trade Unions.

In a sense, this is natural, for the Dock Labour Scheme, which the Report endorses, embodies the distrust of employers as such, in affirming that certain of their management duties should be shared with Trade Unions. It is, however, probably true that the concept created by Ernest Bevin cannot now be changed. There was an opportunity at least to make improvements on it at the end of the war when the employers pressed, to the point of an inquiry, their view that there should be a revision of the Scheme in the light of experience, and of the working conditions of the industry as a whole. The opposition of the Trade Unions, and the indifference of the Government, blocked the move. It is now likely that any modifications in the Scheme, or other improvements, will have to come from the industry itself.

The Devlin Report accuses the Trade Unions of undue complacency in their approach to industrial problems. Here the Report does no more than echo previous investigations, and it is much less constructive in its criticism than was, for instance, the Leggett Report.

Not merely in relation to the Dock Labour Scheme but in the discharge of its industrial responsibilities as a whole, the Trade Unions have no easy task. Much is said of the tradition of loyalty in the ranks of dock labour, and to it is attributed in great part the notorious proneness to strikes. It is doubtful if dock workers are any more loyal to each other than co-workers in other industries. True, they have a tradition of militancy; the Dockers' Unions, like those of other labourers, were born out of this spirit, in the late 19th century, and they quickly learned that without solidarity they could achieve little. They were not, however, peculiar in this respect. They learned too that the strike was a more effective weapon than in most industries, for reasons already stated, and they have always been quick to use it. So-called solidarity can mean merely a blind herd-instinct. There have been many illustrations of this in the docks; there was a case in London last year when men stopped work because they were led to believe, by an unofficial leader, that men in another part of the docks were on strike, when in fact they were not.

There is still far too little sense of responsibility and in particular far too little appreciation of the damage done by stoppages to the industry and to the country. Here the trade unions have a great part to play, in informing their members—and not merely a select few at week-end schools—of the economic facts of life and in weaning them away from the unthinking traditional hostility to employers as such.

This will not be easy. The inherent distrust of employers (well founded as it may have been) is difficult to eradicate, partly because of the nature of the employment and partly because of the nature of the labour. The employment is casual and will remain so except to the extent that men are attached permanently to one employer. This is a process that is going on slowly but steadily all the time, often in the face of Trade Union opposition, for the Trade Unions tend to believe that the greater decasualisation of men thus achieved would intensify the "casualisation" of the rest. It may be that more continuity of engagement can also be given in other ways, not only by job continuity, which operates in many ports, but by a less chancy kind of allocation to work. Engagement by the day instead of by the half-day would, if practicable, be a step in that direction. It would require not merely longer guarantees of employment from the employer, but a readiness on the part of labour to accept more mobility, that is, a readiness to switch from one type of work to another during the period of engagement, instead of, as at present, treating each job as a contract which finishes with the end of the job, however short.

The Recruitment of Labour.

There must be far more care taken than hitherto in the recruitment of labour. The industry is attractive and there is seldom any lack of would-be entrants. The method of selection of recruits has, however, been and still is extremely haphazard. Neither the employers, where they have a say, nor the Trade Unions, have been sufficiently careful in the matter of selection, and nepotism is still prevalent, as with the convention that a docker's relations should be given preference.

In some ports the introduction of temporary registers, by which men are given short-term engagements, has proved very helpful. The recruits who show themselves adapted to the work can then be graduated into the ranks of the permanent labour force, with, in effect, a life-contract, subject to good conduct. Some such system is obviously very desirable and employers, as well as men, will have to do some new thinking along those lines. Along with it should be linked elementary training schemes, not so elaborate as that in Rotterdam, which is tantamount to a complete system of education, but restricted to a scheme of instruction in the more elementary requirements of the industry.

The Responsibilities of the Unions.

The reluctance to do new thinking in such directions is not confined to the Trade Unions but the Trade Unions are notoriously conservative-minded. There are many reasons for this. Inter-Union conflicts have made union leaders fearful of embarking on new policies which, as with all new policies, would expose them to criticism and give the malcontents ammunition. The Trade Unions must, therefore, put their own collective houses in order and either agree upon their respective spheres of influence or, perhaps better, merge into one union.

It is held in some quarters that this latter policy should result in an exclusively dockers' union, instead of there being dockers' sections of large unions. Undoubtedly this would give more cohesion and this is probably the direction in which trade unionism as a whole should develop. Naturally enough, the General Unions are opposed, since this would be contrary to the whole concept on which they are based. The General Unions have given very good service to the dockers. The power of the Transport and General Workers Union and the National Union of General and Municipal Workers is immense, because of their vastness and their range, and this is a tremendous bargaining force when directed to the negotiations of any one section. The theory that a Dockers' Union could gain more benefits for the dockers is therefore extremely doubtful. The charge that the organisation of the General Unions puts them out of touch with their members is also doubtful. The General Unions are like department stores, with various sections of activity, and like them, can function very efficiently in catering for different needs. The specialist union, like the specialist shop, will probably be more sensitive to the demands of its particular customers; but it is not a bad thing that a union should balance the demands of one of its sections against those of its membership as a whole; this gives at least a semblance of a national policy.

The view that the small union is more effective because it is more democratic is nonsense. It is usually based on the argument that in the smaller unions the officials have to come up for re-election periodically, sometimes at quite short intervals, and that this forces them to keep in touch with their membership. What it is more likely to do is to prevent any courageous policies or independent judgment, and to put every issue at the mercy of so-called mass meetings and make a mockery of negotiation.

That is not to say that the big Unions have been in as close touch as they ought to be with their members; it merely means that this is not a fault inherent in the organisation. The big department store requires effective management at all levels and not only at the top. Here the big Unions have been badly at fault. Men have been appointed to positions of extraordinary difficulty with far too little regard for their capacity. Probably not enough of the right men are offering themselves for the posts, which is not surprising in view of the difficulty of their tasks and their comparatively poor remuneration.

It is doubtful if the exhortations of the Devlin Committee will make much impact, or even if they are really necessary. In spite of the troubles, there is a great deal of good-will in the industry and a machinery of conciliation at least as effective as that in any other industry. The great majority of disputes are settled quietly and effectively. What is needed more than anything else now is, first, that the Trade Unions should put their own house in order and, secondly, that both employers and Unions should acknowledge that there are in fact problems to be dealt with, and that their solution will require a new approach as well as new ideas

Diesel Tug for the Manchester Ship Canal

Hydroconic Design Increases Manœuvrability

The Manchester Ship Canal Company recently took delivery of the " M.S.C. Sabre," one of four 1206 S.H.P. twin screw tugs being built by Messrs. P. K. Harris (Shipbuilders) Ltd., Appledore, of hydroconic construction to the design of Messrs. Burness, Corlett and Partners, Ltd., Consultant Naval Architects. The remaining three tugs will be coming into service between now and the end of the year.

The tug has been designed to fulfil the particular towing requirements on the Manchester Ship Canal and the construction of the hull is on the hydroconic principle and embodies certain unique underwater lines, which have made this tug outstanding in its manoeuvring capabilities. The hydroconic form is in essence a system of providing a hull shape formed by a combination of cylindrical and conic sections, which is cheaper and quicker to construct while giving at least the same hydro-dynamic efficiency as a round bilge hull. The difference between the austerity or wartime measure of easily pre-fabricated straight line form and the non-austerity highly efficient hydroconic form is an important one, established by a series of tank tests and trials. It has been proved that in most cases the propulsive efficiency of hydroconic hulls is in fact greater than with corresponding round bilge hulls and in several cases considerably greater. Basically, the improvement in hull efficiency is brought about by a low-resistance form also giving considerably improved flow of water to the propeller, a factor which is particularly noticeable in full-bodied small craft. In addition, such features as the stern frame and rudder provide a thrust augment of considerable value to tugs and trawlers. The patented method of arranging longitudinal members along the connecting lines of conic sections, results in the upper and lower edges of the longitudinals being straight lines but the cross section of the bottom being a curve provided by the conical shape. The system, which is known as the Dioframe Patent, also provides useful strength against panting stresses in the bottom forward by the progressive concentration of frame spacing as the fore end is approached.

The tug, which is 97-ft. (88-ft. b.p.) in length and has a moulded breadth of 24-ft. 4-in., is equipped with twin rudders which, combined with the special underwater lines, contribute largely to the outstanding manoeuvring abilities. During tests it was found that the tug could turn in 1½ to 2 lengths using her rudders and only one engine, a unique feature, and further tests revealed the fact that from full speed ahead speed of over 10 knots the tug could gather astern way in 25 seconds, and that for ahead steering, when using one engine, only 10° of opposite helm was required. The tug is also quite capable of manoeuvring astern on her rudders only.

The accommodation consists of separate rooms for the Master and Chief Engineer, together with a mess room, covered by a service hatch leading to a galley, a separate room for the Mate and a two-bunked cabin for the crew, with adjacent messroom. The galley contains an oil-fired cooking range and refrigerator.

As the tug is to be both ahead and astern operating it is essential that ample astern pull should be provided on the propellers. This entails a compromise design of propeller embodying both ahead and astern pull. This is not a usual feature of tug design but has been specified as an essential by the Manchester Ship Canal Company, consequently propellers have been designed giving a compromise pull of 17 tons when pulling ahead and 10 tons when pulling astern. In addition, the light running speed of the tug is 10¼ knots. The tug has a Diesel oil bunker capacity of 36 tons.

The main external feature of the tug is the absence of a funnel, this having been omitted in order to ensure maximum visibility aft for the Helmsman and Tug Captain when acting as ahead tug. The exhaust from the two main engines is led up the bases of two legs of a tripod mast. These masts are unique in construction and at deck level consist of steel terminating in wooden masts higher up the tripod.

It is understood that this is the first occasion in this type of craft on which a B.H.P. of over 1200 has been successfully exhausted up a mast of this description without the use of the conventional funnel. The design of the tripod mast to fulfil these features was an operation requiring considerable skill as it was essential to avoid any excessive back pressure on the main Diesel engines as well as aiming at keeping the exhaust gas outlet at as high level above deck as possible. This operation has been successfully carried out and it is impossible to detect exhaust fumes on any portion of the deck whatever the direction of the wind. The principal object of dispensing with the funnel was in order to obtain the degree of visibility previously referred to. This is so successful that the Tug Captain has a completely clear view aft and has only minor blockages in a 360 degree view.

Whilst on this feature it might be mentioned that special louvres are provided at the forward end of the exhaust outlet and when the tug is travelling these tend to deflect the exhaust gases in an upward direction and thus help their dissipation into the atmosphere. In practice it has been found that the trunking, both at the corners of the enclosed bridge and where they pass through the accommodation spaces, is absolutely cool and there is no noise

" M.S.C. Sabre " in the turning basin of the Canal.

or sound of exhaust " drum " either on the bridge or in the accommodation. This has been accomplished by the efficient provision of asbestos insulation blocks. In spite of this feature the whole of the exhaust system is accessible from the maintenance angle for cleaning and repairs.

The two main engines are Ruston 6VGBXM 4-cycle Diesel Engines with a continuous B.H.P. rating of 645 and a 12-hour rating of 720, giving an S.H.P. of 603 on each propeller shaft. There are no barred engine speeds on the main engines, critical speeds have been overcome by careful design of gearbox and by introducing a torsional damper situated at the forward end of the main engine on the crankshaft. The engines are directly controlled from the bridge by means of a Chadburn telegraph control and in the event of emergency can be quickly disconnected from the telegraphs and be controlled by hand by the Engineer in the engineroom. The engine controls from the telegraphs are by shafting and mitre gearing and not by rod and chain.

The cooling of the main engines is by means of a closed fresh water system which can be pre-heated before the engines are started. Each engine is fitted with 3 k.w. electric heaters supplied from the auxiliary generator or, if necessary, the main engine water jackets can be heated by the cooling water from the auxiliary engines. One feature of these uni-directional engines is the fact that only three small starting air bottles are required, the engines are continually running whether the tug is travelling or otherwise.

The lubricating oil for the main engines is supplied by a belt-driven centrifugal pump worked off the main engines and in the event of failure provision is made for a hand started 4 h.p. electric stand-by lubricating oil pump to be put into operation to restore the oil pressure. The electric motor for this pump is of Cromp-

Diesel Tug for the Manchester Ship Canal—continued

ton's manufacture, the pump by Hamworthy Engineering Company. Provision has been made for twin elapsed time indicator recorders to be fitted on the main engines and auxiliaries to enable running hours to be quickly determined.

The gearboxes are Hindmarsh M.W.D. Patented Oil Operated Reverse Reduction Gears designed and manufactured by Modern Wheel Drive Limited at Chesham and Slough, and are their No. 5 standard boxes with the exception that the normal 2 : 1 gear ratio has been altered to 2.408 ahead and 2,389 astern. These altered gear ratios were found necessary in order to reduce the slow running R.P.M. of the propeller shafts to 75 without introducing critical speeds. These gearboxes have ample margins over and above the requirements of the British Standards Specification in regard to wear. Each gearbox is fitted with two hydraulically operated brakes fitted on the clutch shafts. These brakes automatically come into operation as soon as the main engine telegraphs are put in the "stop" position. The object of the gearbox brakes is to prevent the propellers from rotating when the tug is acting as astern tug and is being dragged with the engines stopped by the vessel ahead of her.

The normal oil operating pressure for the gearboxes is 50 to 60 lbs. per sq. inch. Should this pressure fall below 40 lbs. per sq. inch there is provision for an automatic electrically operated stand-by gearbox lubricating oil pump to trip in and restore the full oil pressure. The pump is by Hamworthy Engineering Company and the 9 h.p. motor to drive it is of Laurence Scott manufacture. This precaution has been taken in the event of a sudden loss of oil pressure preventing the gearbox clutches from operating and hence the telegraph order from being carried out, and if this should happen in a confined waterway or when approaching lock gates the results might be serious.

The stern tubes are white-metal lined and are lubricated by gravity feed from an oil tank in the engineroom, the external shafting being totally enclosed from the after end of the stern tube to the forward face of the "'A" bracket.

The auxiliary engines consist of two completely independent sets of Lister 6FRM Freedom range Diesel engines directly coupled to a Laurence Scott 25 k.w. generator and there is provision for clutching in a Hamworthy air compressor, and also a Hamworthy 36 tons per hour salvage and bilge pump. Each unit is mounted on a single bedplate which is rubber mounted and eliminates all trace of vibration.

Methods of Marking Cargo

Eliminating Delays in Cargo Handling

An important factor in the quick turn-round of ships is the speed with which cargo can be sorted either in the hold or on the quay. This, in turn, is largely governed by the manner in which goods are marked by manufacturers, a matter which has never received as much attention as it should.

Shipping companies and discharging agents in ports all over the world are continually raising this question and although there has been some progress, a lot more is desirable. The stevedores' troubles mainly arise when large quantities of homogeneous goods are found mixed in the hold. This may occur because of the manner in which goods are tendered to the ship, or because to stow separately would seriously delay the loading process, or because insufficient attention has been paid to the matter by the ship's officers or by the loading stevedore. For whatever reason it occurs, however, the sorting which must ultimately result, can be done much more quickly if the packages are adequately marked.

The steps usually taken with this end in view involve obtaining the co-operation of either individual shippers or large trading organisations. For example, the marking of cases of apples and pears from Australia has been the subject of action by the National Federation of Fruit and Potato Traders Ltd., with whom the Australian Apple and Pear Board have co-operated. The marking of cartons of canned goods from South Africa has the attention of the South African Conference Lines. Bales of plywood shipped from Japan are under discussion. They cause much delay at discharge, because they are not stowed to mark and the packages are not marked for quick sorting. The trouble is world wide.

There are two reasons why proper marking is necessary. One is to ensure that the best possible attention is given to handling; the other has already been mentioned, viz. to facilitate sorting. The first matter has been the subject of British Standard 2770, which recommends the use on containers of pictorial marks to provide easily-understood instructions on the handling of the packages during transit. The second matter—the need for easily-read identifying marks — has been considered sporadically by various organisations but has again been brought to notice by the International Cargo Handling Co-ordination Association. Through its various national committees, this body has submitted to national Chambers of Commerce, standards bureaux and other bodies directly concerned, certain proposals designed to eliminate delays caused at the time of discharge by inadequate marking. These proposals are:—

1. The dimensions of the letters or figures of the leading mark and port mark should be at least 3-in., or 7 cm. high. The dimensions of the submarks should be 1½-in., or 3.5 cm. high.
2. Those marks which are indispensable for recognition and sorting of cargo during transit (the Bill of Lading marks would often suffice) should be grouped inside a standardised "frame" to ensure their immediate identification.
   The "frame" should be in the shape of a square or an oblong, and composed of lines at least ½-in., or 1.5 cm. thick. The "frame" should be as large as is necessary to contain the Bill of Lading marks.
   (Note: Where packages are of such size as not to accommodate marks as indicated above, the marks shall be of the largest practical dimensions in the same scale, i.e. submarks half the size of leading marks.)
3. The "frame" containing the Bill of Lading marks to be on two opposite sides of the package.
4. Submarks which are not necessary to the carrier for the purposes of identification, sorting, handling or delivery should not be put on the surfaces of the packages reserved for the "frame."
   (Note: Submarks which are of value to consignee or receiver only—for example, indent mark, contents mark, advertising mark, official marks and many others—should, if possible, be isolated from the "frame" and be of the smallest legible size.)
5. The "frame" and the characters inside it should be stencilled in an ink of a colour contrasting to the background of the package.
6. Packaging of cargo, in addition to ensuring the security of the contents, should be such as to carry marking as well as ensure that marks remain legible even after several handlings.
7. In the event of packaging being re-used (such as barrels, tea-chests, casks or sacks and bags), all old marks should be completely erased or obliterated, and the new marks clearly made so that no confusion shall be caused between old and new marks.
   (Note: Wood should be either sanded or planed, other materials treated wih dense black paint.)

The "frame" idea is a particularly good one and where adopted will make package identification much easier. It is possible, however, that the consensus of opinion will ultimately be that the "frame" should appear on opposite ends of the package. There is a case for end-marking when the packages are small and oblong —like the conventional carton of canned goods or box of dried fruit.

The proposal that characters inside the "frame" should be stencilled in ink of contrasting colour is also a good one and item 7, which deals with the obliteration of all old marks is, of course, vitally important.

If adopted, these proposals would undoubtedly have an appreciable effect on the speed of discharge of many commodities in many countries.

New Shipbuilding Berth at Kobe, Japan

Semi-Dock Type to Accommodate Super-Tankers

By "ANCAIOS"

Details have been received of a shipbuilding berth which has been constructed under difficult conditions during the eight month's period between 2nd July last year and 1st March, 1956, when the keel of a 45,000 ton deadweight tanker was laid on the completed ways to the order of American owners.

The berth was constructed for the Kawasaki Dockyard Company and is 112-ft. clear width by 705-ft. long. It is of the semi-dock type, having a single-skin gate of 17-ft. 9-in. minimum depth by 115-ft. wide at the seaward end, the total weight of the gate being 75 tons so that it can be lifted clear of the water by an 80 ton travelling crane when the launching of a vessel becomes due. This form of berth has recently received attention in Great Britain, and it is of interest to summarise the points favouring this type of construction:—

(a) Large shipbuilding yards to-day are spending considerable sums in the conversion of existing berths to a smaller number of larger and wider berths, and very considerable difficulty is being experienced in increasing the depth of existing sites, particularly as the area behind the heads of the berths is normally cramped by workshops and other shipyard facilities. Where possible it is therefore desirable to increase the length of a slipway by extending the useful shipbuilding length riverwards.

(b) A semi-dock berth, with its low floor level increases the effective clearance of the booms of travelling tower cranes serving the berth.

(c) The tidal length of a normal slipway is, except during the few seconds of a launch, largely wasted space. This length however is most expensive to construct and to maintain, and the semi-dock berth has the advantage of reducing these costs.

Steel Gate.

The normal tidal range at Kobe Harbour is only 4.6-ft. which, of course, favours the scheme adopted, but it may be that with tidal ranges of up to about 20-ft. a gate which could be bodily lifted clear by a floating or heavy fitting-out crane would be an economic proposition and provide a semi-dock berth of which the entire area could be used for shipbuilding and assembly work. The use of two mitre gates and the consequent triangular shape of the sill would form an obstruction to the vessel's keel, and types of gates which swing open and are secured to the dock walls or floor would, of course, be liable to damage at the time of launching a ship.

It is for this reason that the single leaf removable gate is advocated.

The accompanying photograph (Fig. 1) shows the 115-ft. gate at Kobe being lifted into position by the 80-ton shipbuilding crane designed to serve this berth. The clapping faces on the steel-framed gate bear against continuous water-polished granite blocks set into the concrete sills and quoins. The gate is provided with four sluice valves and is secured against the sill by eight chain slings. Its upper section is supported against wave action during storms by two steel struts raked from the dock floor.

The photograph shows the trapezoidal extension of the gate which covers the rudder pit, a channel of similar section about 148-ft. long by 4-ft. deep by 11-ft. 6-in. wide on the berth centre line at its seaward end. The principal function of this pit is to accommodate the launch "bow drop"—a phenomenon caused by the vessel settling in the trough of the launching wave.

Pumps and Cranes.

The rudder pit does duty as a sump which is served by a bilge suction pump of 200 tons per hour capacity, and by a main pump of 700 tons per hour capacity which can remove all impounded water below the level of low water in six hours.

The berth is at present served by one tower travelling crane of 80 tons capacity at 62 to 82-ft. radius, and 50 tons capacity at the maximum radius of 131-ft. The maximum hoist speed is 115-ft. per minute which is apparently deemed sufficient for handling the large welded block assemblies. The travelling speed is given as 98-ft. per minute. A 50 ton crane of similar outreach is being provided shortly.

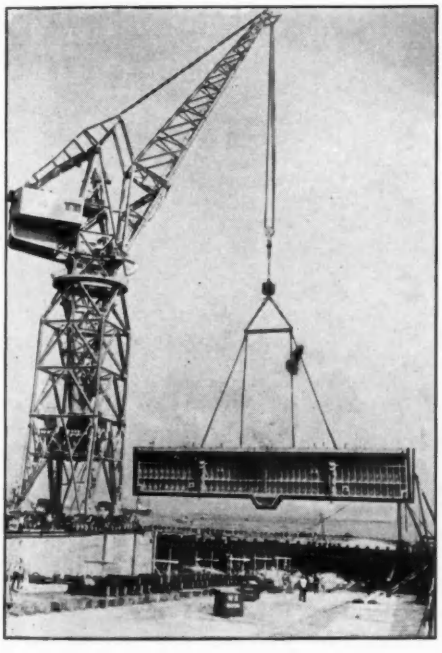


Fig. 1. (Left) 80-ton Crane stepping the Berth Gate. Fig. 2. (Above) The site of the new berth.

Civil Engineering Work.

The new berth occupies the site of two former tidal berths shown on an accompanying photograph (Fig. 2), which was taken on 1st July, 1955. Part of the existing slipway foundations were embodied in the new berth floor, but the existing crane tracks and foundations were removed. Geologically the site is an extremely difficult one, this part of Kobe Harbour being founded on the alluvial delta of the Minatogawa River. The strata down to about 45-ft. below high water are of soft or very soft silts and clays, then a 45-ft. thick layer of water-bearing gravel with thin silty bands overlies further clay and silt. Undisturbed samples from

New Shipbuilding Berth at Kobe, Japan—continued

four boreholes were tested and disclosed that the berth required to be founded on piles carried down to the gravel, and that the success of a coffer dam was in some doubt. Previously a large coffer dam driven in this area had been abandoned in favour of cylinder and caisson construction and in the present case the decision to attempt to build the berth behind a coffer dam was influenced by the large amount of existing underwater concrete and other obstructions which were required to be removed to make way for the low level berth floor.

The Coffer Dam.

The photograph (Fig. 3) was taken on the 29th February this year, and shows the berth completed to a state of readiness for the keel-laying ceremony, and with the coffer dam in the fore-

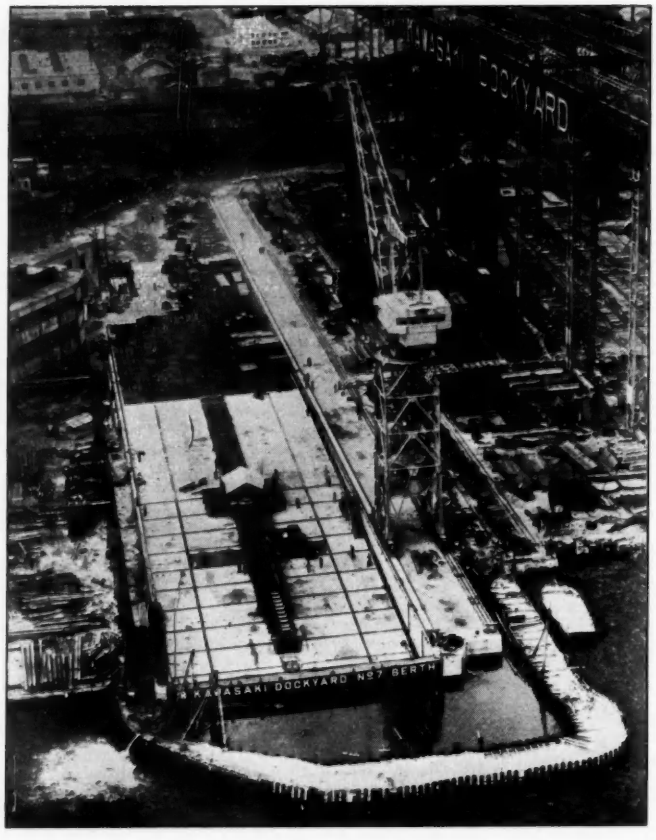


Fig. 3. The completed Berth with Cofferdam in foreground.

ground. The dam which shows numerous changes of section and line at places where difficulties were encountered, is typically of the broad section shown in Fig. 4.

Considerable trouble was experienced, due to vertical settlement, in sections of the dam upon being filled with sand. Corresponding heaving took place of the soft material behind the dam, but the temporary work was successfully completed and the enclosure drained, in just over three months. During the construction period the site was struck by four typhoons and in order to minimise damage to the coffer dam by wave action, the enclosure area was flooded through specially-provided sluices, and the coffer dam filling material was protected by sand bagging. The dam, which is about 200-ft. long with top width varying between 18 and 29-ft., is now being demolished at leisure, during the shipbuilding period.

Floor and Walls.

The berth floor is designed to support vessels of up to 55,000 tons D.W. plus consequent constructional loading, and the additional momentary loading imposed over a central length due to stern lift at the time of launching.. The seaward and central parts of the floor are carried upon 844 in situ pedestal-type reinforced concrete piles carried down to the relatively hard gravel layer. The piles are 17-in. in diameter, vary in length between about 25 and 50-ft. and are designed to carry a safe working load of 70 tons each. The reinforced and mass concrete floor which is laid over 18-in. of stone pitching is 19-in. to 6-ft. in thickness, the landward 365-ft. length of the berth being horizontal and the remaining portion falling seaward at slopes which vary from 1 in 25 to 1 in 17. The lowest floor level is 12-ft. 6-in. below the level of mean high water and it is noteworthy that no pressure-relieving valves are provided, the R.C. piling being designed to take the tension the considerable hydraulic uplift occurring at all states of the tide. In justifying the decision to omit them, it is stated that pressure-relieving valves seldom function satisfactorily and that in this case the underlying stratum was so pervious and silt-laden that such valves would do little more than to slightly reduce the uplift, at the expense of heavy pumping.

Only one transverse expansion joint is provided in the dock floor between the horizontal and the sloping portions, each of these

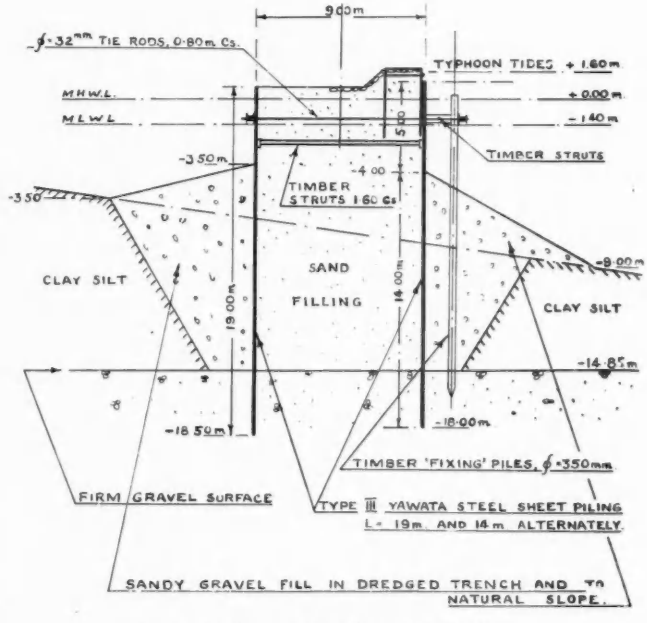


Fig. 4. Typical cross-section of Cofferdam.

portions being subject to the considerable restraint of the in situ piling and of the foundations of old slipways.

The south-side wall is of reinforced concrete designed to withstand earth and water pressure, and the live loading of locomotive type cranes. The north-side wall utilises the separately-piled foundations of the track of the 80-ton travelling crane.

A cut-off wall of steel sheet piling is provided under the sill of the berth.

Acknowledgments.

A thorough soil mechanics investigation of bore-hole samples taken by two independent firms, was carried out in the laboratories of Kyoto University.

The above information has been abstracted from a detailed report made available by courtesy of the Kawasaki Shipbuilding Company, which is to be congratulated upon a speedy and successful project.

Increased Merchant Fleet for Norway.

During the first six months of 1956, Norwegian shipowners were granted licences by the Government to order 1,100,000 tons d.w. abroad. The licences cover 93 dry cargo ships and 16 tankers.

The St. Lawrence Seaway and Power Project

General Design of the Seaway and the Use of Hydraulic Models

THE leading article of the April, 1955, issue of this Journal outlined the implications of the St. Lawrence Seaway and Power Project from the viewpoint of an American contributor, the Port Director of Milwaukee, Wisconsin. Milwaukee, a thriving port on the West shore of Lake Michigan is, with the great ports of Detroit and Chicago, vitally concerned that the 27-ft. ruling depth for navigation which is to operate over the length of the Seaway project, will also be extended to the farthest reaches of the Great Lakes and that these cities will become regular terminals for ocean-going ships.

The article included notes of the political history leading up to the inauguration of the St. Lawrence project, and gave an account of the division of cost and responsibility for the various works, estimated to involve the expenditure of some 850 million dollars in five years. An account of the anticipated economic effects of the Seaway was placed in perspective by a statement of the opposition viewpoint of those bodies which consider that they may be adversely affected by the scheme, and by the more objective opinion of those who believe that the overall economies of both Canada and the United States would be affected only by a change in the location of a trade route, and not by an immediate general increase in the total volume of trade. Certain it is that the locks and canals will be closed to navigation by ice for an average of four months per year, and that the limited navigation season will have its effect upon the employment conditions of maritime labour and the tolls and dues at the various ports. While it is possible that the navigation scheme may not be as dynamic in its economic effects as its most ardent protagonists have claimed, there is no doubt that it is a timely and necessary expansion of present transportation facilities which, together with the power development scheme, will serve a rapidly growing population, a rising standard of living and the growth of industry in the Great Lakes region.

The article concluded with a description of the ground-breaking ceremony inaugurating the power project, and was accompanied by a full-page plan of the River St. Lawrence showing the sites of the various works comprising the project between Prescott, Ontario and Montreal, Quebec.

The two articles which follow are abstracted from papers read before the Engineering Institute of Canada by members of the St. Lawrence Seaway Authority, the body established in 1951 by enactment of the Parliament of Canada for the purpose of carrying out all the navigation works required for a deep waterway between the Great Lakes and the Atlantic Ocean. The paper by D. M. Ripley is a very useful general description of the various features of the Seaway and Power projects, of which the major schemes are as follows:—

In Canadian Territory.

(a) Deepening of Welland Canal from 25-ft. to 27-ft.
(b) Dredging in Lake St. Francis.
(c) Construction of locks passing Beauharnois Power Station.
(d) Construction of canal and locks passing Lachine Rapids.

International Section.

(a) Dredging in the Thousand Islands and International Rapids sections.
(b) Construction of Iroquois lock.
(c) Construction of canal and locks at Barnhart Island.

This article includes interesting sections dealing with the features which integrate with existing municipal services and with the Lachine Power Development.

The second paper, by D. McIntyre, on the use of hydraulic models in the planning and design of the Seaway, outlines the scope of the various model investigations giving brief descriptions of the models and the information obtained or being sought from them.

In order to assist reference to the location of the various works mentioned in the papers, Fig. 1 has been prepared to show the approximate position of the works sites relative to topographical features and to the new average controlled water levels.

FIG 1. THE ST. LAWRENCE SEAWAY—PRESCOTT TO MONTREAL

Approximate mileage	Topographical Feature	Seaway Feature	Final average elevation in feet above M.S.L.
0	**Prescott** (north bank) **Ogdensburg** (south bank)		244.0
4—11	Galop Rapids	Hydraulic cuts	
11	**Iroquois** (north bank)	Iroquois Control Dam and Lock	242.9 242.0
11—16	Ogden Island Reach		
35	Croil Island	Entrance to Long Sault Canal (U.S.A.)	
35—40	Long Sault Rapids		
40	Barnhart Island	Barnhart Island power houses to be passed by Robinson Bay and Grass River Locks (U.S.A.) Long Sault Spillway Dam	241.5 200.0 155.0
41	Cornwall and Cornwall Island	Re-location of south span of Roosevelt Bridge	
41—46	Cornwall Island Reach		
46	St. Regis Island and head of Lake St. Francis	End of International Rapids Section. St. Lawrence river lies wholly in Canada. Dredging in Lake St. Francis of deep water channel	
73	**Valleyfield**	Entrance to Beauharnois Power Canal	
74	Railway bridge. **Soulanges**	Replacement by vertical-lift bridge	
80	Road/railway bridge	Ditto	
86	Road/railway bridge	Ditto	
87	Existing Beauharnois Power Station. Highway No. 3 bridge crossing	To be passed by Upper and Lower Locks with highway tunnel under the latter	150.2 109.0 70.6
89—104	Lake St. Louis		
104	St. Nicholas Island		
105	**Lachine** and **Caughnawaga.** Mercier Bridge (to be raised)	Dredged channel	
107	Lachine Rapids	Cote St. Catherine Lock and bascule bridge	70.0 36.5
112	**St. Lambert** Victoria Bridge	St. Lambert lock, lift bridge	35.0 22.0
114	Jacques Cartier Bridge (to be raised) and **Montreal**	Turning basin	

It was estimated in June this year that over 11,000 men were employed on the Seaway and Power projects, and that this figure by now would be considerably greater. The five year construction programme is up to its planned schedule, and the present position regarding the major contracts awarded in the various sections of the Seaway is as follows:—

Welland Canal Section—3 Contracts totalling	$1,200,000
International Rapids Section—2 Contracts totalling ...	$8,000,000
Lake St. Francis Section—3 Contracts totalling	$6,000,000
Soulanges Section—4 Contracts totalling	$32,000,000
Lachine Section—22 Contracts totalling	$64,700,000
Miscellaneous Contracts totalling	$10,100,000
Total	$122,000,000

Three current progress photographs showing the constructional methods employed upon works at Iroquois, St. Lambert and Mon-

The St. Lawrence Seaway—continued

treal are reproduced at Figs. 2, 3 and 4. Fig. 2 shows a 250-ton gantry crane setting in place the huge forms for the concreting of the walls of Iroquois Lock, the most Westerly of the seven Seaway Locks. About 1,500 cubic yards of concrete is being placed per working day. Fig. 3 illustrates the method of placing concrete for the walls of the St. Lambert Lock near Victoria Bridge, Montreal, and Fig. 4 shows the progress in enlarging the piers of the Jacques Cartier Bridge prior to the permanent raising of the bridge structure for the passage of ships in the Seaway Channel.

Excavation work for the canals and locks under the Canadian Authority will involve the removal of about 49½ million cubic yards of clay, gravel and rock, the total length of new canal construction being 21 miles. In addition, some 26 miles of channel dredging involving nearly 13 million cubic yards of gravel and rock will be carried out. About 1¾ million tons of concrete will be placed in these Seaway locks and structures. The figures just quoted do not include the quantities involved in the concurrent power developments of the Ontario Hydro-electric Power Commission and the Power Authority of the State of New York, or of the dredging and construction work being undertaken by the United States Agency, the Saint Lawrence Development Corporation.

The "Dock and Harbour Authority" hopes to publish further articles from time to time upon various aspects of the planning, design and construction of the Seaway and Power Project, and to give news of the progress of sections of the work.

Fig. 2. Iroquois Lock site. Placing forms for concreting of walls.

General Design of the Seaway

By D. M. RIPLEY
(Senior Assistant Engineer, Hydraulics)

From the Canadian point of view the St. Lawrence Seaway may be defined as the works necessary to provide and maintain, either wholly in Canada or in conjunction with works undertaken by an appropriate authority in the United States, a deep waterway between Lake Erie and the Port of Montreal. The object of this development is to place the Great Lakes ports in direct communication with the lower St. Lawrence River and ocean transport. Fair and reasonable tolls are to be established to place the project on a self-liquidating basis.

Navigation Standards.

The standards adopted for the St. Lawrence Seaway conform to those of the Welland Ship Canal, which, although completed in 1932, was constructed to dimensions that anticipated the early extension of deep-draft navigation facilities eastward to Montreal and the increase in traffic that would result as a consequence.

As at the Welland Ship Canal, the St. Lawrence Seaway will have locks 80-ft. in width and 859-ft. in length. The usable portion of the locks between breast wall and gate fender will be 765-ft. The depth over lock sills at minimum low water conditions will be 30-ft.

The controlling channel depth will be 27-ft. The bottom width of navigation channels and canals will be not less than 200-ft. where flanked by embankments on both sides, not less than 300-ft. where flanked by one embankment and not less than 450-ft. where both banks are submerged. These widths are to be increased where cross currents make navigation more difficult or where required to reduce current velocities to those suitable for navigation. In general, average current velocities in channels to be used for navigation will not exceed 4.0-ft. per second. Somewhat lower current velocities will be provided at lock entrances and in similar locations where vessels will be required to reduce speed. The minimum radius of curvature for navigation channels will be 5,000-ft. with a minimum distance between bend reversals of one quarter mile.

The minimum vertical clearance provided at bridges will be 120-ft.

Division of Responsibility.

In May, 1954, President Eisenhower signed the Wiley-Dondero Bill, an act passed by the Congress of the United States authorising an American agency to construct navigation works on the United States side of the St. Lawrence River between Cornwall Ontario, and Lake Ontario. Corresponding legislation in Canada, The St. Lawrence Seaway Authority Act, which was proclaimed in force in July, 1954, authorised the St. Lawrence Seaway Authority to proceed with the seaway construction, according to Section 10 of the Act, "either wholly in Canada, or in conjunction with works to be undertaken by an appropriate authority in the United States." The close co-operation between Canada and the United

Fig. 3. St. Lambert Lock. Placing concrete for walls.

The St. Lawrence Seaway—continued

States, which has prevailed in all matters relating to boundary waters, resulted in the construction arrangement for the seaway that is now in effect. While acknowledging the right of each country to construct seaway facilities on its own side of the river, Canada initially will construct the seaway locks and canals at Iroquois, Ontario, and at Beauharnois and Montreal, Quebec, together with the channel work in Lake St. Francis and St. Louis and Montreal Harbour, and the deepening of the Welland Ship Canal. The United States agency, the Saint Lawrence Development Corporation, will construct the navigation locks and canals from Lake St. Francis to above the Barnhart Island Powerhouse and the channel deepening on the United States side of the international boundary in the Thousand Islands Section. In all, Canada will construct five locks with connecting canals and channels, and the

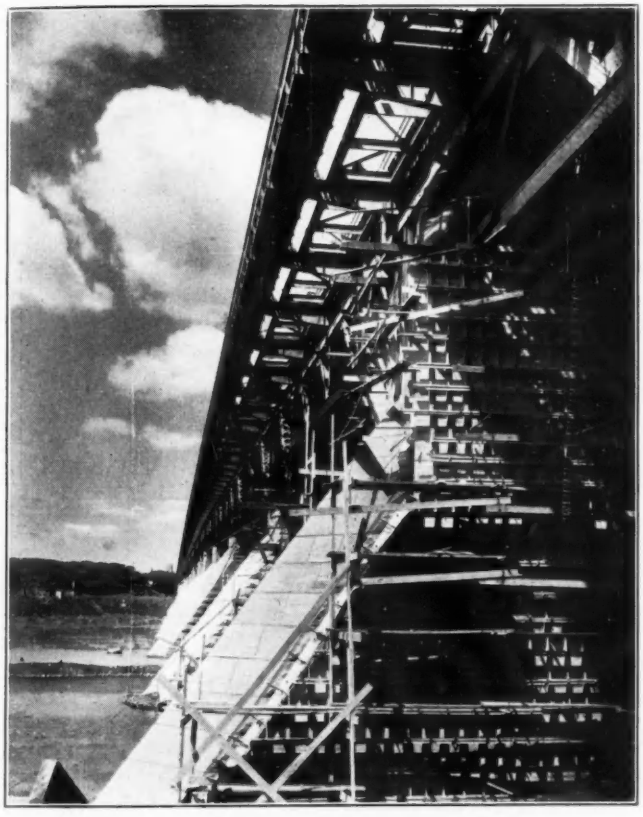


Fig. 4. Jacques Cartier Bridge. Preparatory work on enlarging the piers.

United States will construct two locks with connecting canals and channels.

Power Developments.

Concurrent with the construction of the St. Lawrence Seaway is the large-scale development of power on the St. Lawrence River at two sites and possibly three. The development of power in the International Section of the river near Cornwall, Ontario, will make available to the Province of Ontario and the State of New York equal shares of some 2,200,000 horsepower. This power development will facilitate the navigation improvement as a result of the creation of a lake-like reach extending from the Barnhart Island Powerhouses to Iroquois, Ontario, at which point the Iroquois Control Dam, a structure to be used to regulate the outflow and levels of Lake Ontario, will be located. Enlargement of the river above the Iroqouis Dam by the power entities will provide satisfactory navigation channels.

The second of the power developments, the Beauharnois plant of Hydro-Quebec, was begun in 1932 and has been under continual expansion since that time. The present Beauharnois plant develops about 70 per cent. of the more than 2,000,000 horsepower potential at that site, and the broad deep headrace canal which diverts water to the powerhouse from Lake St. Francis will provide a navigation canal in a 600-ft. wide portion along its northerly shore.

At Montreal, the Lachine Rapids will provide at least another 1,000,000 h.p. When this power potential at the Lachine Rapids is developed the St. Lawrence Seaway will tie in with the construction and operation of the power works in a manner to be described later.

Principal Seaway Features.

The major works of the St. Lawrence Seaway are located in the 114-miles portion of the St. Lawrence River between Montreal, Quebec, and Prescott, Ontario. Relatively minor dredging above Prescott, through the Thousand Islands and in the reaches between the locks in the Welland Ship Canal complete the standardisation process.

All Seaway features are being so located and designed that extension of navigation facilities, including twinning of the locks, may be accomplished with a minimum of difficulty to meet traffic demands in the future.

Compared to the 47 miles of canal reaches of the present St. Lawrence Canals, the Seaway canal reaches will be reduced to 40 miles. Of more importance, the number of lockages will be reduced to seven from the present 22. The resulting saving in time of passage from Kingston to Montreal will be at least 12 hours. Another significant comparison is the increased capacity of the seaway canals. The present canals accommodate vessels carrying 3,000 tons while the seaway canals will handle ships carrying over 20,000 tons.

Welland Ship Canal.

Downbound vessels from the upper lakes when passing through the Welland Ship Canal will find the controlling channel depth increased from the present 25-ft. to 27-ft. The existing canal will be widened in places to 350-ft. to facilitate passing. The contracts for this work, which call for excavation in the dry during the winter months from Thorold to Lake Ontario and dredging from Thorold to Lake Erie, have been awarded and the work is in progress. Dry excavation in this latter portion of the canal is not possible because of the necessity for continuance of a diversion of water down the canal from Lake Erie for domestic and power purposes.

The Welland Ship Canal will be otherwise unaffected; in fact, as mentioned above, this canal provides the standard for the Seaway features elsewhere. Experience gained in construction and operation of the Welland Ship Canal has been, and continues to be, an invaluable aid in the design of the St. Lawrence Seaway. The St. Lawrence Seaway Authority is fortunate to have on its staff several engineers formerly employed on construction and operation of the Welland Ship Canal.

Port Weller to Prescott.

From Port Weller the vessel track is 120 miles across Lake Ontario to Kingston where shipping enters the St. Lawrence River. Below Kingston the first navigation improvements encountered will be the enlargement of the present navigation channel through the Thousand Islands. Although the channel from Kingston through the Thousand Islands to the National Harbours Board elevator near Prescott is now in regular use by the largest of the upper lakes bulk carriers, it will be widened and deepened by dredging to conform to the seaway navigation standards. The work in this section of the river on the Canadian side of the International boundary will be carried out by the Seaway Authority and that on the United States side by the Seaway Development Corporation.

Prescott to Cornwall.

Beginning at a point four miles downstream from Prescott, navigation will encounter a complete change of circumstances in comparison with those now existing. At the Galop Rapids, which form the natural outlet control of Lake Ontario, the power works begin in the form of a series of large hydraulic cuts specified in the Order of Approval of the power project. The navigation

The St. Lawrence Seaway—continued

Fig. 5. Iroquois Lock and Dam Sites.

channels will be so located to take advantage of these channel enlargements. The Order of Approval requires that the average current velocities in the cross sections of the channels to be used for navigation must not exceed 4.0-ft. per second at any time during the navigation season. The design and construction of these channels is primarily the responsibility of the power entities and exhaustive studies of these works are being made by Ontario Hydro at their Islington, Ontario, Hydraulics Laboratory. The design has now been accepted by all concerned and at the time of writing requires only the final approval of the St. Lawrence River Joint Board of Engineers, the approving agency of the Canadian and United State Governments. Briefly, the navigation standards have been met with a channel of 600-ft. minimum width. Curvature is moderate and the hydraulic model studies indicate no objectionable cross currents.

About 15 miles down river from Prescott will be located the Iroquois Control Dam, the structure required to replace the natural outlet control for Lake Ontario that will be removed by the Galop Rapids excavation. Construction of the Iroquois Dam by the power entities is well advanced. This may be seen to the right in Fig. 5. To the left may be seen the excavation for the Iroquois Lock, the navigation feature required to by-pass the dam.

The Iroquois Lock is being constructed by the St. Lawrence Seaway Authority. A contract was awarded in January, 1955, and completion is scheduled for opening of navigation in 1958. The unique feature in the design of this lock is use of sector gates. Filling and emptying of this lock will be through the gate openings rather than the more conventional culvert filling system.

The current velocities that will be experienced at the approaches to the Iroquois Lock have been studied on the Ontario Hydro river models at Islington, Ontario. These and other model tests undertaken by Ontario Hydro have provided the data for the stablishment of the sill elevations and gate heights at the Iroquois Lock.

The normal lift at the Iroquois Lock will vary from a few tenths of a foot, when the Iroquois Dam is fully open, to 5.5-ft. during the period when the water level above the Barnhart Island Powerhouses is at a maximum elevation 238.0, for a test period as required by the Order of Approval. The Iroqouis Lock is being designed also to permit its use by 14-ft. navigation for a short time during the construction period, when the water level above the Iroquois Dam will be raised and the river below the dam kept as under present conditions. Under these circumstances the lift at the Iroquois Lock may be as much as 24.5-ft. Provision for such a lift will also permit use of the lock at 14-ft. draft should emergency circumstances arising after the seaway and power projects have been placed in operation require lowering of the pool between the Barnhart Island Powerhouses and the Iroquois Dam.

Proceeding below the Iroquois Lock, shipping will pass through the lake-like section created by the raised level at the Barnhart Island Powerhouses. Channels of at least the standard set out above will be available in this portion of the river. At Croil Island, 20 miles below the Iroquois Lock, vessels will enter the Long Sault Canal. This work, which is being undertaken by the Saint Lawrence Development Corporation, will provide an access canal 10 miles in length to the Robinson Bay and Grass River Locks. These locks divide about equally the lift required to overcome the fall of 87-ft. at the Barnhart Island Powerhouses. The Robinson Bay and Grass River Locks are separated by an intermediate pool which is to be controlled at about elevation 200.0. Basically these locks are similar in dimension to those at the Welland Ship Canal.

Immediately downstream from the Grass River Lock will be undertaken an extensive channel enlargement designed to lower the current velocities in the South Cornwall Channel to the 4.0-ft. per second required by navigation. Compensatory excavation will be done concurrently in the North Cornwall Channel to maintain the flow distribution to either side of Cornwall Island either as in nature or as agreed upon by Canada and the United States. A

The St. Lawrence Seaway—continued

necessary requirement of this compensating excavation is that it will be so located and designed as not to preclude or make more difficult the future development of navigation on the Canadian side of the river near Cornwall, Ontario.

In the Cornwall area the Seaway encounters the first vehicular crossing. A combined railway and highway bridge, the Roosevelt Bridge, presently crosses the North Cornwall Channel at Cornwall and the South Cornwall Channel about two miles below the Grass River Lock. Improvement for navigation will require the relocation of the south span of this bridge. This will be accomplished by a new movable bridge across the Grass River Lock with a new fixed span across the International Boundary. The north span at Cornwall will remain unchanged for the present.

Cornwall to Beauharnois.

Below the head of Lake St. Francis, a few miles downstream from Cornwall, the St. Lawrence River lies wholly in Canada and from this point to Montreal the seaway construction is being undertaken by the Seaway Authority.

Across Lake St. Francis the navigation channel follows a practically direct course for 30 miles to the Beauharnois power canal. Dredging required to deepen and widen the navigation channel at Fraser Point, Lancaster Bar and near the power canal entrance is now in progress.

The upper entrance to the Beauharnois Locks will be provided by the Beauharnois Power Canal. Under the terms of the Order-in-Council authorising the diversion of water for power purposes at Beauharnois, the power canal has been constructed to include a 600-ft. wide navigable portion of adequate depth along the north bank.

The Beauharnois Locks will be very similar to the Robinson Bay and Grass River Locks in relation to each other. The fall from Lake St. Francis to Lake St. Louis of about 82-ft. will be overcome by two locks separated by an intermediate pool having a controlled water level at elevation 109. These locks are equipped with mitre gates and a conventional side-filling and emptying system. The usual guard gate for ensuring retention of the upper pool in case of a gate failure resulting from collision by a vessel has been replaced by an emergency sector type gate, which may be closed against a head of water should a gate failure occur. A considerable saving in time for a vessel to transit the canal is thus effected. Contracts were awarded recently for the preliminary work on the Beauharnois Locks construction.

In the 15 mile length of the Beauharnois power canal there are a railway bridge and two combined railway-highway crossings. The three present bridges—one near Valleyfield, another near St. Louis and one near the Beauharnois Powerhouse—will be replaced by vertical lift bridges. Highway No. 3 will be carried under the locks through a tunnel thus eliminating any possible interruption of highway traffic.

Beauharnois to Montreal.

Proceeding down river from the Beauharnois Locks the navigation channel follows the naturally deep water in Lake St. Louis for 10 miles until above St. Nicholas Island, from which point the channel comes close to the south shore. A dredged channel 600-ft. in width leads to the canal entrance near Caughnawaga. Dredging of this channel has been in progress since early in 1955.

In the past there have been many proposals for the improvement of the Lachine Rapids section for navigation. Some of these proposals were to be carried out concurrently with a power development. Although at the time of writing no power development appears likely in the Lachine Section in the immediate future, the St. Lawrence Seaway will be so constructed in the Lachine Section that the power development may be carried out at a later date.

An overland channel of 250-ft. minimum width and eight miles in length is being excavated through rock from Caughnawaga to Cote Ste. Catherine, where a lock is now under construction as

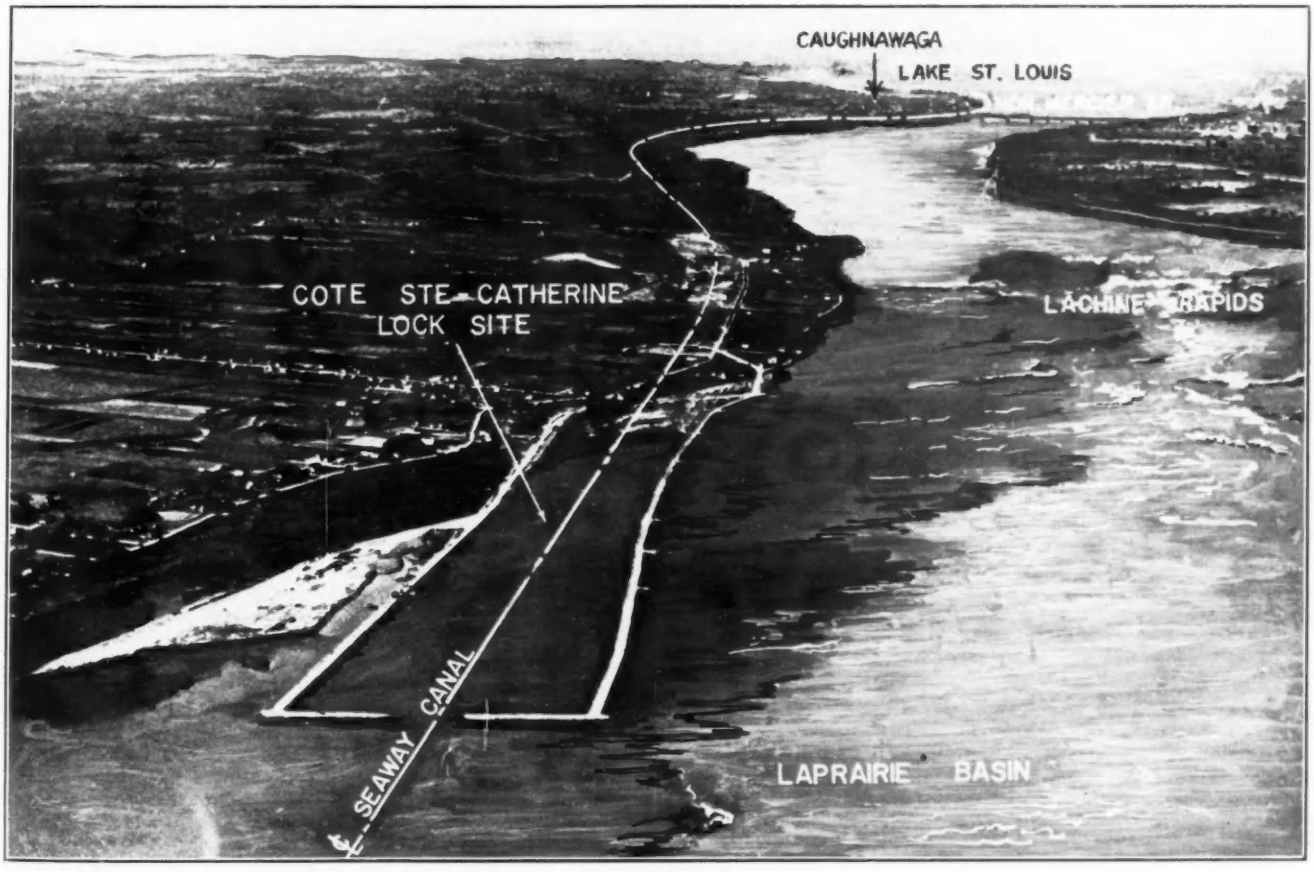


Fig. 6. Cote Ste. Catherine Lock Site.

The St. Lawrence Seaway—continued

Fig. 7. St. Lambert Lock Site.

shown in Fig. 6. The Cote Ste. Catherine Lock will have an average lift of 33-ft. It will be equipped with mitre gates and a side-filling and emptying system. As at Beauharnois, an emergency operating sector type gate will be installed to ensure retention of the upper pool in case of a gate failure.

From the Cote Ste. Catherine Lock the navigation channel will be isolated from Laprairie Basin by a continuous dyke through the eight mile length of the channel down to St. Lambert. The pool formed by the dyke will be controlled during the navigation season initially to elevation 35.0.

At St. Lambert the lower lock of the St. Lawrence Seaway will be constructed. The lock location in relation to topographic features is shown in Fig. 7. The approach channel below the St. Lambert Lock and the dyke that separates the channel from the river may also be noted in this view. The approach channel is being excavated in rock with finished side slopes at 1.5:1 and the Seaway construction actually will terminate in Montreal Harbour where a turning basin is being dredged to facilitate entrance to and exit from the seaway canal without undue interference with port traffic.

Because of the wide variation in river stage experienced in Montreal Harbour during the navigation season the St. Lambert Lock, which will have an average lift of 13-ft., must handle shipping at river stages requiring lifts varying from 20-ft. at low water to only 2-ft. at high water.

Integration with Muncipal Services.

The integration of the Seaway features with municipal and other facilities in the Montreal area raises many interesting problems. These problems arise because of the many service facilities intercepted by seaway construction such as highways, railways and water and sewerage systems.

At Longueuil and St. Lambert new water supply intakes are being constructed to replace those removed or interfered with by the seaway construction. Similar facilities are being continued and improved upon where required throughout the length of the seaway canal.

The bridges in the Lachine Section are being raised where possible and both the Hon. Mercier Bridge and the Jacques Cartier Bridge will be raised to give 120-ft. clearance. Modern traffic distribution systems will be constructed at the southerly end of both of these bridges. Grade limitations, however, necessitate the installation of movable bridges at Victoria Bridge and at the Canadian Pacific Railway Bridge at Caughnawaga. The Canadian Pacific Railway Bridge will be provided with a vertical lift span.

A combined railway and highway lift span crossing the lower end of the St. Lambert Lock, and additional highway rolling-lift bridge crossing the upper end of the lock, and a traffic distribution system will enable highway traffic to continue to use Victoria Bridge without interruption during passage of vessels through the St. Lambert Lock.

At Cote Ste. Catherine a rolling-lift bridge across the lock will complete the bridge picture in the Lachine Section. However, provision for an additional rolling-lift bridge may be made at Cote Ste. Catherine, having in mind the need for increased traffic capacity should a power development near Heron Island be undertaken in the future.

Integration with Lachine Power Development.

When the Lachine Rapids power development is carried out, presumably with a powerhouse located near Heron Island, a considerable enlargement of the Lachine Rapids will be required to reduce the current velocities to the 2.0-ft. per second considered necessary to permit an ice cover to form in the river above the powerhouse. Hydro Quebec have indicated that a channel enlargement in the Lachine narrows to a 120,000 square feet cross sectional area is the economic limit. This means that a Lake St. Louis outflow of 240,000 cusecs can be handled in the river during the

The St. Lawrence Seaway—continued

ice forming period. The more recent plans for regulation of Lake Ontario call for a maximum river flow at Lachine of 280,000 cusecs during the ice forming period. To enable such a plan of regulation to be put into effect the Seaway Authority has agreed to make available the seaway canal from Caughnawaga to Cote Ste. Catherine as a by-pass canal during the non-navigable season. Under this arrangement, which will also require discharge works into the river below the future powerhouse near the Cote Ste. Catherine Lock, the Seaway canal will carry the 40,000 cusec discharge in excess of the river capacity.

Seaway Construction will not Affect Water Levels.

It is natural that those who own property or operate businesses on the shores of the St. Lawrence River, Lake St. Francis, Lake St. Louis or Montreal Harbour, should express some concern regarding the water level conditions that will obtain after the Seaway is completed. The Seaway Authority is taking steps to ensure that the construction of the seaway features will not alter natural conditions. The St. Lawrence River discharges will be influenced by the regulation of Lake Ontario which will be carried out as recommended by the International Joint Commission and approved by the Governments of Canada and the United States. Studies in the matter of Lake Ontario regulation are continuing under the direction of the International Joint Commission but it has now been established by approval of the Canadian and United States Governments that Lake Ontario, which has ranged in the past between elevation 242.6 to elevation 249.3, will be regulated within a range of stage 244.0 (navigation season) to 248.0, as nearly as may be.

These continuing studies in the matter of Lake Ontario regulation will recognise the requirements of the downstream interests and the plan finally approved for operation will ensure that circumstances at least as favourable as those of record will be maintained.

Except for the river reach from near Prescott, Ontario, to the Barnhart Island Powerhouses, where there will be a substantial change in river levels resulting from the power development that must be provided for, the Seaway project has been designed to conform to the present river regime.

Geological Conditions.

In general the geological conditions prevailing along the Seaway route are favourable for seaway construction. In the Montreal area bedrock consists of Lorraine and Utica shales; at Caughnowaga these formations give way to Trenton limestone. Bedrock is Potsdam sandstone at Beauharnois and dolomitic limestone at Iroquois. The overlying soils are mostly glacial in origin and consist of a very dense till, which occurs in deposits up to 100-ft. in depth, and scattered deposits of marine clay principally near Beauharnois. The sedimentary rocks are excellent for foundation for the lock structures and rock fill. The glacial till is a satisfactory material for dyke construction but presents many excavation problems because of its extreme density.

Concrete aggregates for the lock structure at Iroquois are being produced from a clean dolomitic limestone being quarried about three miles westerly of Iroquois. In general, all concrete aggregates must meet all A.S.T.M. and C.S.A. specifications.

Construction Materials and Estimated Cost.

The following table of materials going into the project will furnish some idea of its magnitude.

	Canada	U.S.
Dry Excavation: Rock ...	16,000,000 cu. yds.	60,000 cu. yds.
Common ...	36,000,000 cu. yds.	25,000,000 cu. yds.
Wet Excavation: Rock ...	7,000,000 cu. yds.	270,000 cu. yds.
Common ...	15,000,000 cu. yds.	4,600,000 cu. yds.
Fill and Dyke construction ...	11,500,000 cu. yds.	10,100,000 cu. yds.
Concrete	2,000,000 cu. yds.	1,030,000 cu. yds.
Reinforcing steel	14,000 tons	2,500 tons
Sheet Steel piling	6,000 tons	6,150 tons
Structural Steel	27,000 tons	11,235 tons

The estimated cost of the Canadian and United States features is $320,000,000. This amount is made up of $215,000,000 for the works being constructed by the St. Lawrence Seaway Authority and $105,000,000 by the Saint Lawrence Seaway Development Corporation.

Progress in the seaway construction to date has been satisfactory. The completed seaway is scheduled to be in use with the opening of navigation in 1959. The Iroquois Lock and the United States locks at Robinson Bay and Grass River as well as other Seaway facilities upstream from Lake St. Francis will be ready to operate in time to permit generation of power at the Barnhart Island Powerhouses in July, 1958.

The Paper by D. McIntyre, M.E.I.C., on the use of Hydraulic Models will be printed in next month's issue.

Drilling Platforms in South China Sea

Launching and Placing 25 Miles Offshore

A steel oil-drilling platform has recently been set into position in the South China Sea, twenty-five miles from the coast of Brunei, British Borneo. The location, known as Ampa Patches, is a coral reef lying thirty feet below the surface of the sea and appears on marine charts as a hazard to shipping. A second similar platform is shortly to be set up eight miles from the coast of Sarawak and sixty miles south-west of Ampa Patches. The water here is in the region of 75-ft. deep. This latter location does not appear on any charts and has been given the arbitrary name of Siwa, owing to the fact that the nearest geographical feature is a small river of that name. The total cost of these two projects when completed is estimated by the Shell Group of Companies to be approximately £625,000.

Both of the new marine out-stations will be virtually self-contained communities. They will have their own radio stations, powerhouses, materials sheds, and helicopter landing platforms. Drilling crews, who will travel to and from the shore by helicopter, will live in comfortable air-conditioned quarters which will be separated from the drilling platforms by short oversea gangways.

Both of the new platforms are much larger than the three which already operate a mile off the coast of Brunei. They have been designed to store enough drill-pipe, casing, cement, mud and other materials to allow a complete well to be drilled without having to resort to supplies of heavy material from the mainland. From each platform it will be possible to drill four wells: one vertical and three at an angle.

The foundation dimensions of the platform are 45 by 210-ft. and, in all, a total of 800 tons of steel is required. The supports consist of four 48-ton "jackets," measuring 30 by 45-ft. and 50-ft. in height and spaced at 30-ft. intervals. Each "jacket" is a separate lattice-braced structure consisting of six jacket tubes, 49-ft. long and 30-in. in diameter, through which 24-in. diameter steel piles of ½-in. wall thickness are driven about 35-ft. into the coral seabed. The space between the pile and the jacket tubes is grouted with cement.

The jackets were assembled on shore in the British Malayan Petroleum Company's marine construction yard at the mouth of the river Belait, a few miles from Seria oilfield after the components had been pre-fabricated in Britain, Holland and Hong Kong. They were then carried out to sea by two tower-like steel gantries mounted on two 700-ton barges, spaced 50-ft. apart and tied firmly by two 45-ton connecting box girders. Each pair of jacket tubes, suitably braced to form a panel 30-ft. wide and 49-ft. high, was built into the gantries where the final bracing of each group of six tubes was carried out to complete the unit. The gantries were able to accommodate two jackets, which were thus taken to the location in pairs. The launching of the first pair took place twelve weeks after the arrival of the material in the construction yard.

Three days prior to the planned launching date, the Company's vessel "Frostylight," which had been fitted with a helicopter landing platform and living quarters to act as base ship, was towed to the Ampa Patches location. On-the-spot weather conditions were

Drilling Platforms in South China Sea—continued

therefore regularly transmitted to base. When weather and sea conditions were favourable, the loaded gantry barges were towed out from the marine construction yard and over the River Belait bar at high tide. Speed of the two was 3 knots. Arriving at the location at daybreak, where a 1-ft. swell was running, the gantry barges were moored by tugs and winching to the exact position was commenced. To carry out this manoeuvre, special moorings had been placed a few weeks previously.

As soon as the barges were correctly located, strain on the jacket-lifting tackle was taken, after which the braced units of jacket tubes were unbolted from the supporting brackets. After 70 minutes, these were hanging free and ready for lowering. The swell meanwhile had increased to 2—3-ft., due to a force 4 wind. Five minutes later the lowering was commenced, using four 50-ton capacity travelling blocks and 7½-ton capacity handwinches, specially equipped for lowering on the brake. Within 45 minutes, the units were submerged to a depth of 27-ft. and lowering was stopped for a quarter of an hour to allow a diver to check that the bottoms of the jacket tubes would not be fouled by boulders on the coral bed. After receiving the diver's all-clear, the units were lowered the remaining 6-ft. to the sea bed in 4 minutes, and landed in a practically level position. The hoisting tackle was then released and tied back to the gantry.

With a 5-ft. swell running and in heavy rain, it took about an hour to tow the gantry barges entirely free of the jackets, for which operation one of the box girders connecting the two barges had to be raised to clear the top of the structure.

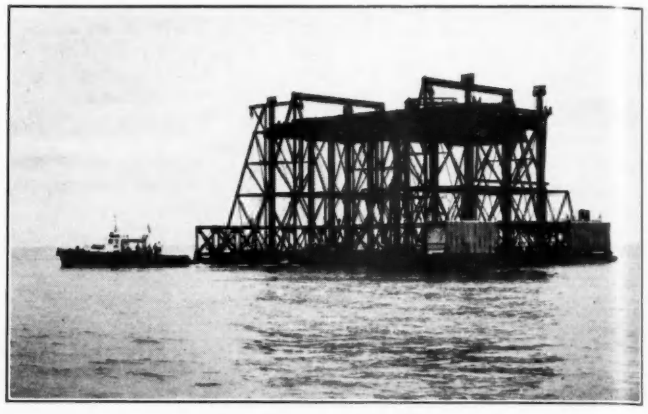
When the second pair of braced jacket tubes were brought to the location a few days later, they were guided into the approximate position by the barges and then eased into the exact position by a hinged spacing template attached to the first pair. The yoke was gradually lowered to the horizontal, maintaining the second pair of jackets in their exact position in the process.

To level the four units after siting, each of the four corner piles of a pair of jackets was provided with a top cross-beam which carried rope blocks matched to blocks fitted to lifting lugs on the jackets, and these were adjusted as necessary.

Once the units of jacket tubes had been placed on the sea bed, the final erection began. To avoid hazard in transferring workers on and off the site in rough weather, two prefabricated living quarters with accommodation for two engineers and sixteen labourers were built on the first pair of jackets, prior to the tow to the location. These units were removed when permanent quarters for the drilling phase were completed.

Experience with the earlier offshore platforms had indicated that working with a floating crane was limited to the calmest weather period in local sea conditions; therefore, for piling and the erection

The lowering of the spacing template to water level prior to the final positioning of second pair of jackets.



First pair of jackets being towed to their location at Ampa Patches.

of steel-work, a special guyed derrick was the first item to be erected on the jackets after siting. This derrick is skidded to various positions during construction in order to complete the piling and erection of the superstructure over the 210-ft. length of the platform.

A compression ignition driven hammer was used for the piling, instead of the conventional steam-hammer, thus eliminating the need for boiler equipment and the associated supply difficulties of fuel and water.

The completed drilling platform has a lower floor, 180 by 64-ft., carrying the mud system, cementing units, bulk storage, etc., and an upper floor, measuring 180 by 60-ft., carrying the draw-works, engines, generators and pipe-rack. These floors are supported by the 18 piles of three of the units of jacket tubes. The other six piles of the fourth unit provide the foundation for the 50 by 60-ft. of prefabricated living quarters for 32 men, and, above them, the 50 by 50-ft. landing area for the helicopters.

The drilling rigs will be capable of reaching to a depth of 10,000-ft.

Docks and Inland Waterways Charges

British Transport Commission Scheme

The British Transport Commission have submitted to the Transport Tribunal for confirmation two separate draft schemes of charges—one for port facilities provided at their docks, and the other for the use of their inland waterways (and port facilities on the waterways). The scheme for the docks lays down maximum charges which may be levied, but their approval does not necessarily mean that the Commission will raise the existing charges to these levels. This is the first time that draft schemes for harbours and inland waterways have been submitted to the Transport Tribunal as required under the Transport Acts, 1947 and 1953; a railway charges scheme was submitted in March.

The harbour charges draft scheme covers dues on ships, merchandise and passengers, and charges for services and facilities specified in the scheme. It distinguishes between scheduled harbours which comprise the more important dock undertakings of the Commission, and non-scheduled harbours which are the smaller docks. In the case of scheduled harbours, maximum charges are proposed for dues on ships merchandise and passengers, with reasonable charges for all other specified services and facilities. In the case of non-scheduled harbours, provision is made for reasonable charges for all services and facilities. Actual charges within duly authorised maximum charges at scheduled harbours would be at the Commission's discretion. Reasonable charges would be subject to the jurisdiction of the Transport Tribunal, on appeal.

The draft scheme provides that the use of any services or facilities shall be subject to such reasonable terms and conditions as the Commission may decide upon, but any question as to reasonableness would be determinable by the Transport Tribunal. Although under the scheme the Commission would be under no obligation

Docks and Inland Waterways Charges—continued

to publish any charges other than the authorised maxima, it would be their intention to continue their present practice which is to publish their actual charges currently in operation.

The harbours of the Commission to which maximum dues apply are: Ayr, Barrow, Barry, Bo'ness, Burntisland, Cardiff, Dunston Staiths, Fishguard, Fleetwood, Folkestone, Garston, Goole, Grangemouth, Grimsby, Hartlepools, Harwich, Heysham, Holyhead, Hull, Immingham, King's Lynn, Lowestoft, Lydney, Methil, Middlesbrough, Newhaven, Newport, Parkeston Quay, Penarth, Plymouth (Millbay Docks), Port Talbot, Silloth, Southampton, Stranraer (East Pier), Swansea, Troon.

Inland Waterways.

The Inland Waterways charges draft scheme provides for reasonable charges for the use of any of the Commission's waterways and for the provision of towage thereon, and for the use of any services or facilities provided by the Commission at or in connection with any dock on their Inland Waterways. The scheme is not concerned with any charges made by the Commission for carriage by Inland Waterways, which by virtue of the Transport Act, 1953, are now at the discretion of the Commission. The use of any of the services and facilities to which the scheme relates are to be subject to such reasonable terms and conditions that the Commission may impose, any question as to reasonableness being determinable by the Transport Tribunal.

Copies of either draft scheme can be obtained from the British Transport Commission (Room 360), 222, Marylebone Road, London, N.W.1, or from the Chief Commercial Manager, 87, Union Street, Glasgow. The price is 1s. 6d. for a copy of the Harbours scheme, and 1s. for a copy of the Inland Waterways scheme; both are post free.

Commission Visits South Wales Ports.

Previous to the announcement of these draft schemes, the British Transport Commission had held a three day meeting at Cardiff, during the course of which Sir Brian Robertson, chairman of the Commission, spoke of the charges at South Wales ports.

He refuted the suggestion that the British Transport Commission was chiefly responsible for the higher cost of shipping goods through South Wales ports as compared to the Mersey ports and said that the problem was not merely a question of railway rates, but also a question of handling costs. He noted that although the total handling cost is not higher in South Wales than on the Mersey, the apportionment of costs between the exporter and the shipowner at present favoured the exporter using the Mersey. Sir Brian stressed that of the three parties involved the exporters, the shipowners and the Transport Commission, the first two were the ones chiefly concerned, and the problem was not one the Commission could rectify on its own. Sir Brian went on to speak of the improvements carried out by the Commission since taking over the South Wales ports. He said that although more than £3 million had already been spent, there was still room for more improvement and the reason for the visit of the B.T.C. was to examine future projects.

Surveying Ships by Ultrasonics

Economies Effected by Simplified Technique

One of the heaviest items in the maintenance costs of a ship is the repair work necessitated by wastage of the plating and bulkheads. The problem is particularly acute where oil tankers are concerned, since corrosion takes place not only by sea water from the outside, but also by the crude oil or refined products carried in the tanks.

The normal method of checking for corrosion is to drill holes to enable mechanical gauges to be inserted, after which the holes must be closed again by riveting or welding. The disadvantages of this process are obvious, but so far no satisfactory alternative has been available. Drilling is a costly operation, both in time and labour. Another drawback is the fact that seepage may occur around badly welded plugs, giving rise to subsequent excessive corrosion. Especially on tankers carrying spirit, the danger of fire or explosiion due to such seepage necessitates expensive tank tests.

These disadvantages and difficulties have recently been minimised by the introduction of ultrasonic gauges, which it is claimed, can measure the thickness of plates of which only one side is accessible, without the need for drilling holes. Recent advances in electronics have made it possible to produce a battery-operated, self-contained and portable gauge which is sufficiently simple and robust for constant use on open sites by ordinary maintenance personnel. The instrument, known as the Type 1101 Ultrasonic Thickness Gauge and made by Dawe Instruments Ltd., London, is shown in Fig. 1. It operates on the resonance principle, a variable oscillator within the instrument generating an ultrasonic signal, which is injected through a crystal probe into the plate whose thickness is to be measured. Just as light is reflected by a mirror, so the signal is reflected by the far, or inaccessible, side of the plate and is picked up again by the probe. If the outgoing and reflected signals are in phase, they will reinforce each other and resonance occurs. This condition is easily recognised by a sudden rise of the hum in the earphones, and by a sharp deflection of the needle of the meter mounted on the instrument.

Resonance can only occur if the wall thickness is a direct multiple of the wavelength of the signal. In operation, the probe is applied to the plate and the wavelength is slowly changed by means of the control knob, until resonance is achieved. The adjustment for resonance is extremely sharp. The thickness of the plate is read off a scale graduated directly in inches, and is found

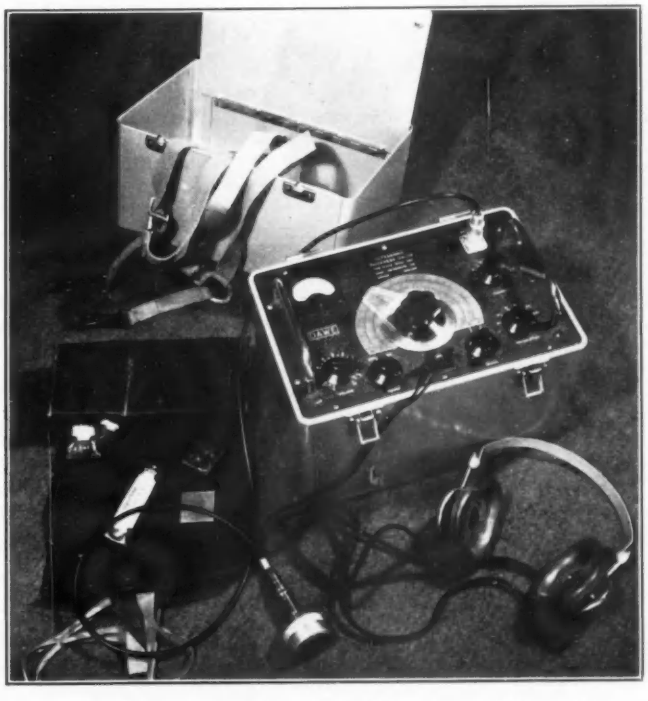


Fig. 1. Dawe Type 1101 Ultrasonic Thickness gauge. The earphones, probe, carrying harness and other accessories are normally housed in the detachable lid.

opposite another scale showing the fundamental measurements from 0.06-in. to 12-in. in steel, and for a similar range in most other metals.

The latest model of this gauge, which is provided with a 50-ft. lead between the instrument and the probe, has been developed specially for the shipping industry. The long lead enables one operator to apply the probe in high or awkward locations, while another operator, at a central position, takes the readings on the gauge. It is thus often possible to dispense with the need for staging and to use ladders instead, with a consequent saving in time and cost.

Surveying Ships by Ultrasonics—continued

The advantages to be gained from the use of ultrasonic gauges appeared to be so impressive that Shell Tankers Ltd. decided some time ago to give this method a trial. Tests were first carried out on tankers due to be scrapped and were so encouraging that they were extended to tankers in service. Several difficulties had to be overcome. The first of these was to devise a satisfactory method of cleaning a spot on the plate to be measured. The probe of the gauge must be applied directly to the metal, to enable the signal to be injected into it. Paint, scale and dirt must therefore be removed. Heavily pitted surfaces must be smoothed, to provide a sufficiently large area of contact between the probe and the plate. It was eventually found that an air-driven grinder with a medium-coarse wheel provided the most convenient solution.

Another difficulty arose over closely adhering scale on the far, inaccessible side of the plate. Such scale can absorb the signal, so that it becomes impossible to obtain a reading. This is, of course, useful insofar as it prevents the scale from being measured as part of the thickness, which may happen when using a mechanical gauge, but posed a problem where accurate readings were required. It was, however, found that a few vigorous hammer blows sufficiently loosened the scale to eliminate its damping effect. Various other difficulties have in the meantime been overcome by the manufacturers, by providing a smaller probe of greater sensitivity, a longer lead between gauge and probe, and earphones with better mufflers, to cut out the noise inevitably associated with dockyard work.

Although the final routine has not yet been decided on, it seems that a team of three to five men will be able to carry out an ultrasonic survey of an entire ship. One man precedes the gauge operator with the air-driven grinder to prepare the surfaces for the application of the probe. The second man operates the gauge, while the third takes readings, moves the ladder and gives whatever other assistance may be needed. The operator's job is simplified by the provision of a magnetic probe holder. This consists of two permanent magnets, one on either side of the probe, and of a steel strip by means of which the gauge is held in close contact with the plate, so that the operator has both hands free to attend to the gauge.

If many readings have to be taken in inaccessible places which require the constant movement of ladders or planking, the addition of further men to the team considerably speeds up the work.

Special charts have now been devised and are supplied to gauge operators for entering the readings obtained at various positions. These charts are filed and represent a permanent record of the condition of the ship's plating and bulkheads. The readings can also be chalked on the plates, to assist steel inspectors to appraise their condition.

The direct and indirect consequences of ultrasonic gauging are so far-reaching, that it is difficult to compare its cost with that of drilling. The current tariff rate for drilling in non-watertight locations, for instance, is 3s. 6d. per hole, while the rate for drilling, tapping, plugging and welding a hole in a watertight location is 11s. 6d. On one 18,000 ton dead-weight tanker the number of watertight locations requiring drilling in the course of an owner's inspection survey is approximately 600, while the number of holes drilled at non-watertight locations amounts to about 1,200. Thus the cost of drilling alone amounts to £560 and to this must be added the platers' or inspector's time, the cost of erecting staging and, where accommodation bulkheads are concerned, the cost of removing and making good panelling and deck coverings.

The cost of ultrasonic gauging depends largely on the skill and speed of the gauge team, but there can be no doubt that by dispensing with a lot of staging, important economies can be effected. Fig. 2 shows, for instance, how two operators can gauge the hold of a tanker without any staging whatever, by taking full advantage of the 50-ft. lead for the probe.

The cost of grinding and gauging should generally be appreciably less than that of drilling and making good, and there is also a saving in time. To prepare a spot for gauging takes a grinder about one minute, the exact time taken depends on the location of the spot and the degree of pitting. With some experience, the complete ultrasonic gauging of a spot can be completed in about two minutes.

A further saving in time is achieved by the elimination of much of the repair work to panelling and flooring when working on accommodation deckheads, since it is usually not necessary to disturb them. This factor should be of considerable importance on passenger-carrying ships.

In the course of their tests, Shell Tankers Ltd. carried out many random checks on ultrasonically gauged locations by drilling and direct mechanical gauging which, it is stated, showed the possibility of obtaining without difficulty readings with an accuracy of

Fig. 2. The 50-ft. lead between instrument and probe enables two men to gauge the hold of a tanker without staging. Even the most difficult locations are accessible by ladder.

±0.005-in. for plate thicknesses lying between 0.25 and 0.5-in., thus giving readings at least as accurate as those obtained by means of the conventional calliper gauge.

In the United States, ultrasonic gauging is already widely accepted, and several firms have formed service departments which undertake ultrasonic surveys on a contract basis.

Tests carried out with the gauge have been witnessed by surveyors of Lloyd's Register of Shipping and as a result readings taken with the instrument are accepted on certain occasions for assisting surveyors in assessing the condition of a hull, except where drilling is specifically called for by the rules, and provided a reasonable number of check drillings (of the order of 20 per cent.) are taken at the surveyor's discretion.

It is unlikely that drilling will be entirely eliminated, but as skill and experience in the handling of the new gauge accumulate, the extent of drilling will probably be greatly reduced. The consequent direct and indirect savings in time and labour can only benefit the shipping industry and the application of ultrasonic plate thickness gauging to dock and harbour craft such as dredgers, hoppers, barges and tugs, as well as lock gates, caissons, floating docks and steel sheet piled structures would appear to be indicated as a natural sequence.

Hopper Transport of Dredged Spoil

An Important Feature of Port Maintenance

By D. W. LOW, O.B.E., M.I.Mech.E., M.I.Mar.E.

VAST amounts of dredged spoil are removed from the site of excavation by hydraulic transport or by hopper transport. Where practicable, hydraulic transport by pumping through floating and shore pipelines is substantially the cheaper method. For a variety of reasons this method has not been freely applied in the United Kingdom but it is extremely popular abroad, particularly in U.S.A. It is of great use in capital dredging schemes but, for port maintenance dredging, spoil disposal by hopper barge or hopper dredge retains an almost undisputed supremacy. The remarks which follow are directed to this method of spoil transport.

In the dredging world a hopper is a receptacle or container into which dredged material is deposited. A hopper barge is a vessel fitted with a hopper into which dredged spoil is delivered by a dredge for carriage to deposit area. The hopper is generally fitted with bottom opening doors or valves through which the spoil is dumped but in certain circumstances closed bottom-dry-hoppers are also used. Hopper barges also serve other purposes, e.g. the carriage of ash from pulverised coal power stations, of steelworks slag and of the residue from sewage works. In the last type of vessel closed tanks are fitted instead of an open hopper.

A hopper dredge is equipped with a hopper into which the dredging plant discharges the spoil raised from the bottom through a distribution system. Such dredges may be of the multi-bucket, grab bucket or suction types. The multi-bucket hopper type is out of vogue although it had a long period of popularity and still has a limited use where small amounts of dredging are required at widely dispersed places. The grab bucket and suction types continue to grow in popularity, the former in the United Kingdom and the latter overseas. In U.S.A. the term "hopper dredge" is not qualified by "suction" because operators do not think in terms of bucket hopper or grab hopper dredges. Briefly then the hopper is an open compartment or hold designed to carry dredged material.

Without dredging and the removal of spoil from the coastal waterways of the world many of the ports would cease to function. This in turn would stifle sea-borne trade and all that means to shipowners, shipbuilders, marine engineers and a host of other commercial and industrial interests. To convey some idea of the extent of this work a schedule has been prepared which lists the amounts of dredged spoil removed during the four year period 1951-1954 by some British Port Authorities and which indicates the maximum and minimum distances through which the spoil has to be carried by each Authority.

Quantities of Spoil Removed by Dredging from Sea Channels, Rivers and Docks.

Year	1951	1952	1953	1954
Authority	**Mersey Docks and Harbour Board**			
By Multi-Bucket Dredge	826,335	775,550	654,650	785,180
By Grab Bucket Dredge	2,020,345	2,156,820	2,929,240	3,462,240
By Suction Dredge ...	6,681,490	12,441,430	13,894,310	10,488,530
Total in tons	9,528,170	15,373,800	17,478,200	14,735,950
Authority	**Tees Conservancy Commissioners**			
By Multi-Bucket Dredge	1,160,516	1,408,179	1,323,594	1,380,168
By Grab Bucket Dredge	52,043	21,382	29,048	21,030
By Suction Dredge ...	252,051	220,863	614,641	555,219
Total in tons	1,464,610	1,650,424	1,967,283	1,956,417
Authority	**Port of London Authority**			
By Multi-Bucket Dredge	3,036,147	3,217,671	2,921,986	3,127,279
By Grab Bucket Dredge	228,988	294,176	278,050	300,950
Total in tons	3,265,135	3,511,847	3,200,036	3,428,229
Authority	**Clyde Navigation Trust**			
By Multi-Bucket Dredge	1,178,025	1,156,050	966,375	1,075,275
By Grab Bucket Dredge	136,308	148,237	146,325	177,525
Total in tons	1,314,333	1,304,287	1,112,700	1,252,800
Authority	**Port of Preston Authority (Ribble Navigation)**			
By Suction Dredge ...	2,919,951	2,493,649	1,920,154	2,127,678
Total in tons	2,919,951	2,493,649	1,920,154	2,127,678

	Average Annual Quantity of Spoil Removed during period 1951 / 1954 in tons	Distance spoil is carried to deposit area in miles	
		Maximum	Minimum
Mersey Docks	14,279,030	20	4
Tees Conservancy ...	1,759,683	16	1
Port of London	3,351,312	70	45
Clyde Navigation ...	1,246,030	28	10
Port of Preston ...	2,365,358	16	4

The Mersey Docks and Harbour Board operate a fleet of about thirty dredges and ancillary craft constantly dredging and carrying sand and silt from the sea channels, river and docks. The problem of keeping the Mersey open to navigation against the forces of nature is immense and of this clear evidence exists in the average annual rate of spoil removal. The present fleet includes:

3 Suction Hopper Dredges.
6 Grab Hopper Dredges.
4 Multi-Bucket Dredges.
12 Hopper Barges.

These vessels are on constant week-day and night service and are frequently employed on week-end duty, all as part of the port service to shipping.

In order to maintain the navigable channels in the Mersey area some 10,500,000 tons of sand are dredged and deposited at sea every year. This work is effected by self-propelled suction hopper dredges, one of which has the very large hopper capacity of 10,000 tons, regularly filled with sand from the sea channels by the dredging pumps in approximately two hours. Two other vessels of similar type can each carry a cargo of 3,500 tons in their hoppers.

At the entrances to and within the dock system the problem of siltation is severe and to meet this service self-propelled grab hopper dredges are used. In this type of vessel single or multiple grab cranes raise dock silt and mud from the bottom by grab bucket and discharge into the hopper. With a full hopper each vessel proceeds to sea under its own power to release the cargo. A fine system of operation has been developed, based on the principle that docks must be maintained at required depth without interference to shipping and the loss of revenue-earning berthing space.

The multi- bucket dredges are used mainly for maintenance work at the river entrances and at certain jetties. They are also employed on capital dredging, sometimes for prolonged periods, as the need for such work arises. These dredges are not equipped with hoppers and discharge the dredged spoil into hopper barges for transit to deposit ground. About eight units of the hopper barge fleet serve the bucket dredges while the remainder is employed on the carriage of quarried stone which is deposited on the revetments of the sea channels.

On the Thames the major part of the maintenance dredging consists of mud but small amounts of clay, sand and ballast are encountered. There is the usual continuing fight against siltation. This problem is under constant investigation in order to devise more economical methods of removal and to reduce, by scientific means, the quantities to be removed. All dredging is accomplished by multi-bucket dredges in association with hopper barges and by grab hopper dredges. The hopper barges are required to make a long passage to and from the dumping ground but the grab hopper dredges deposit their cargoes within the limits of the Port of London Authority at distances between 20 and 8 miles from the dredging positions. Experiments with suction dredging have so far been inconclusive but this method may yet prove to be the economic answer to maintenance dredging in this great river where conditions would appear to offer scope for its adoption.

Hopper Transport of Dredged Spoil—continued

About two-thirds of the annual tonnage quoted for the Tees Conservancy was carried to a deposit ground at sea in self-propelled craft. The remainder of the output was pumped from barges to a reclamation area within the limits of the Authority. For the most part the work on this river is performed by multi-bucket dredge and grab dredge in association with hopper barges. The Authority, however, operates one self-propelled suction hopper dredge which in recent years has contributed greatly to improved maintenance dredging in the sands of the sea channels. Experimental work is proceeding on the handling of up-river silt with encouraging results.

The Clyde Navigation Trust operates a dredging fleet of:—

4 Grab Hopper Dredges
4 Multi-Bucket Dredges
13 Hopper Barges.

No suction dredging is employed but amongst the ancillary craft is a diving bell barge adapted for sub-aqueous rockbreaking by means of explosives, a system whereby rock is pulverised under water for elevation to hopper barges by bucket dredging. A 15-ton rock-cutting chisel has recently been added to the equipment of this vessel to enable rockbreaking to be carried out by percussion as well as by blasting. The dredging craft are employed almost exclusively on maintenance dredging, the multi-bucket dredges being used in the navigable channel of the river and in the dock areas and the grab dredges alongside the quays and wharves on the river-side and in the docks.

On the Ribble a fleet of self-propelled suction hopper dredges is in service and until 1952 seven dredges of this type were working. The slight drop in spoil output for 1953 and 1954 was caused by a reduction in operating fleet to four post-war dredges. Maintaining the river by dredging such large quantities each year imposes an onerous charge on the Port of Preston but there is little doubt that the cheapest method is employed to suit the circumstances. In addition the Authority operates grab dredges and hopper barges for dock service and for carrying stone to the training walls of the river.

Sub-aqueous soils loaded by dredging into hoppers could be classed under these general headings which, however, are not exhaustive. Soil densities vary substantially hence these stowage ratings are indicative only.

Material	As Stowed in Hopper
Silt	25/29 cub. ft./ton
Mud	21/23 cub. ft./ton
Sand and Clay	18/20 cub. ft./ton
Sand and Gravel ...	17/20 cub. ft./ton
Fine Sand	17/19 cub. ft./ton

Each of these materials has some inherent feature which demands attention in design. It is obvious that a hopper designed to carry a cargo stowing at 18 cub. ft./ton could carry appreciably more volume when loaded at 27 cub. ft./ton provided the capacity was available. Conversely it is a very easy matter to overload a hopper designed specifically to carry any of the lighter spoils if protective devices are not embodied. The hopper deadweight should be based on the class of material which the hopper is intended to carry and the freeboard and load drafts be arranged accordingly. For general purpose craft an empirical stowage of 20 cub. ft./ton is usually accepted but where a hopper is designed for, say 25 cub. ft./ton material, physical safeguards against overloading should be incorporated.

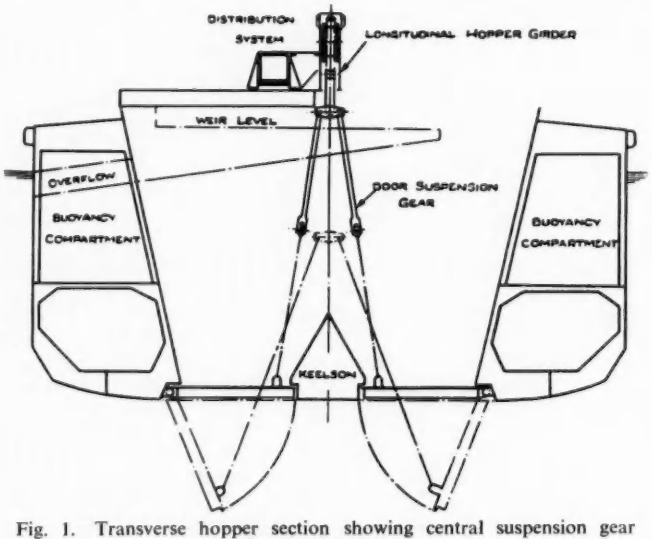


Fig. 1. Transverse hopper section showing central suspension gear for hopper doors.

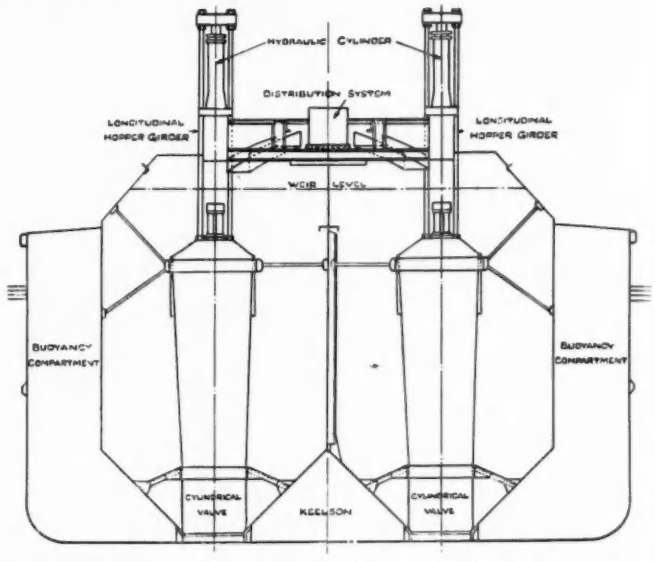


Fig. 2. Transverse hopper section showing cylindrical hopper valve arrangement.

The ease with which cargoes are released from hoppers through the bottom openings varies with the nature of the material. Silt drops out easily. Dumping a load of sticky mud normally presents no trouble except that the residual material clings to door chains, at points where the hopper plating or girders intersect near the bottom and at any structural members which break the smoothness of the downward flow. Medium and coarse sands release in general with the opening of the doors but very fine sands, or cargoes like fly ash from pulverised coal firing, may pack solidly in the hopper and tend to arch over the doors when these are opened. A sticky clay—and most clays are more or less—can be a perfect nuisance to dump. Rock cargoes have a high permeability and the design of the hopper should avoid jamming of the rock on dumping. The ratio of voids in the hopper varies with the size of broken rock, small pieces giving a better stowage rating than large lumps. Many rock cargoes are deposited on the training walls of navigable channels after the vessel is positioned over a certain spot. This work is frequently done in shallow waters and requires that, when open, the doors should not protrude below the bottom of the ship.

Fig. 1 is a typical cross-section of a hopper and illustrates the predominant features of the hopper equipment. A central longitudinal hopper girder arranged horizontally at deck level carries the door operating gear. This is operated through a worm drive and a long hopper screw which is directly connected to the drawbar located on the hopper beam. Four pairs of bottom doors are fitted and each pair is directly connected to the drawbar. The weight of the hopper load on the doors is carried on a wedge which is manually released just prior to dumping. This system is slow in opening and in closing the doors and has the disadvantage that all doors are operated together so that if one door is fouled by foreign matter the remainder cannot be closed properly. Individual door adjustment is provided.

The steel hopper doors are hinged longitudinally and on opening drop away from the centre keelson to hang vertically below

Hopper Transport of Dredged Spoil—continued

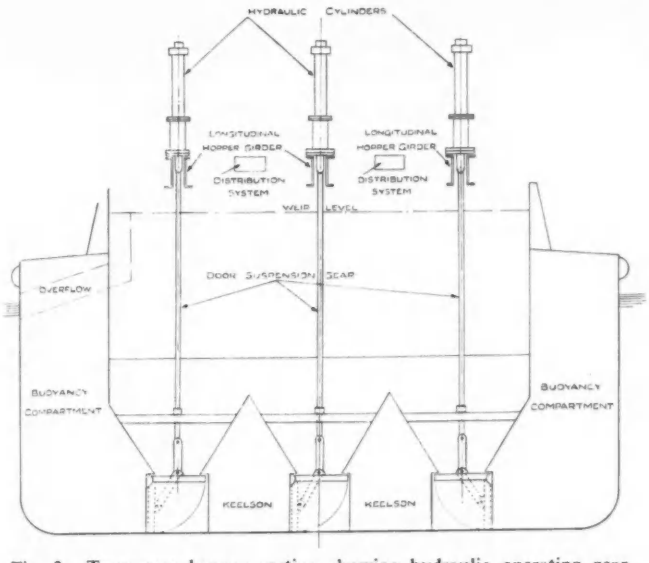


Fig. 3. Transverse hopper section showing hydraulic operating gear for hopper doors.

the ship from the outboard sides of the hopper. Doors which hang thus, on dumping the cargo, are subject to slamming in bad weather. In the process of closing, the doors approach the hull and severe impact with the hull can and does occur with quite frightening intensity. This disadvantage, however, has not precluded the continued use of this type of door but recent craft have been equipped with hopper door gear arranged for speedier operation. Rapid closing of the doors is advantageous by virtue of the reduced period prone to slamming. The rate of discharge of cargo is not necessarily governed by the rate of door opening. The nature of the cargo has a pronounced effect and in this dredge the average dumping time for the cargo of about 675 tons is under 10 minutes.

When closed, hopper doors should form a seal effective enough to retain the cargo but seldom, if ever, is this seal watertight against the pressure of the sea. Ease of maintenance should be considered in design for in both suction and bucket dredging the amount of junk uplifted from the bottom and discharged into the hoppers is incredible. Wires, chains, ropes and all sorts of trash have a notorious habit of wrapping around door hinges and chains and of fouling landings. Many ideas have been tried to secure a better standard of tightness in hopper doors but while some are better than others none, so far as the writer knows, have proved ideal. Doors are recessed into the hull bottom when closed but the depth of these door recesses is kept to an absolute minimum in order to obtain a near-flush bottom and the improvement in propulsion resistance which accrues.

The transverse hopper section shown in Fig. 2 applies to a vessel equipped with six large cylindrical rubber-seated valves, each situated to cover an opening in the hopper bottom. The system offers important advantages in hopper tightness and in ease and simplicity of maintenance when compared with hopper doors and in the fact that the dredge can deposit under adverse weather conditions. In normal sea conditions about 25 minutes are required to empty this hopper of 1,900 tons of free-running sand and release of the cargo is usually accelerated by any liveliness of the ship in a seaway. A record of the dredging time lost due to bad sea conditions by this dredge and by a companion ship fitted with ordinary doors shows that over one Autumn and Winter season the former lost 9 per cent. and the latter 27 per cent. of possible working tides and that this loss relates only to the incidence of door slamming in the latter vessel and its avoidance in the former. Hopper valves, however, also have disadvantages. There is additional weight to carry, loss of displacement by water entering the valves and loss of hopper capacity due to the large volume of the valves. The area of each opening in the bottom and the slopes of the hopper structure leading to the openings are unsuited to any spoil which has an adhesive or cohesive quality and some loss in speed may be expected due to the valve seats not being flush with the bottom.

The cross section of the hopper shows the twin hopper girder arrangement on which are disposed six hydraulic cylinders. Each hydraulic piston is directly connected to a cylindrical valve, sometimes known as a Lyster valve. A Hele-Shaw pump delivers oil to the hydraulic system at a pressure of 1500 p.s.i. and this serves both the pistons for the valves and all movements of the suction pipe by remote control from an operating house on the bridge. The pistons actuating the hopper valves are single-acting, the oil being passed to the underside of each piston to raise the valve when about to dump the cargo. The valve returns to its seating on release of the oil pressure.

At one end of the hopper near deck level the overflow weir is located. This is arranged to pass overboard the excess liquid mixture which occurs when pumping continues after the hopper has been filled initially. When dredging a material which settles rapidly the liquid passing overside is mainly water but where slow settlement occurs this overflow is liable to carry a high ratio of the solids pumped into the hopper. The hopper distribution system should allow for the longest possible distance between inlet and overflow weir and for the least surface velocity. The surface area of the hopper and the position of the overflow have a pronounced effect on the ability to retain solids in the hopper and a certain ratio between pump discharge volume and hopper surface area is desirable though not always attainable. The problem of spoil settlement is essentially related to the type of material being dredged and is at its worst in silts.

Another hopper gear of a type favoured in American hopper dredges is illustrated in Fig. 3. The doors are nearly square and are much smaller in area than the large rectangular type almost exclusively fitted in British practice. These American type doors in most cases are raised and lowered by vertical rods coupled through links to anchorage eyes on tops of the doors. When these are open the links lie across the aperture and tend to become fouled by junk passing out of the hopper. This can keep the door from closing properly and may even cause damage to it; further, the rod and link system is subject to bending in service. The apertures below the doors provide either a partial or full cover for the open doors and are subject to a fair degree of abrasive wear. These openings also offer propulsion resistance to the dredge, raise the centre of gravity of the hopper cargoes and incur some loss of displacement. The most popular means of door control is by individual hydraulic operation. In spite of the objections mentioned this class of hopper equipment has served exceptionally well in American hopper dredges and does not appear to have been superseded although much experimental work has been undertaken on other good ideas.

The design of hopper shown in Fig. 4 has certain advantages and is extensively used in non-propelling barges. The hopper is

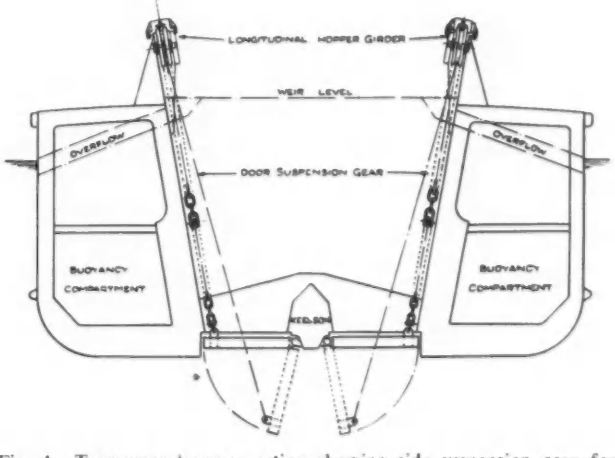


Fig. 4. Transverse hopper section showing side suspension gear for hopper doors.

Hopper Transport of Dredged Spoil—continued

unimpeded by girders at deck level or door equipment on the centreline. Both for grab and multi-bucket dredging the clear open hopper surface is attractive. The door suspension chains are nested parallel to the hopper sides and the door hinges are fitted on the centre keelson, thus the doors on opening, travel towards the centreline. Some operators consider that this location for the door suspension gear is preferable to having this equipment in the centre of the hopper. During loading the chains are out of the way but when dumping they lie across the spoil and are no better than an installation where the doors swing outboard from the centreline to open. In large barges the width at the bottom of the hopper accommodates two doors in the transverse direction but in many smaller vessels the hopper is arranged to be only one door wide at the bottom. The hopper doors may be operated in a number of ways. The simplest method is where each door is released on knocking out a wedge and is raised by a wire connected to a winch. In the vessel to which this section applies two hydraulic cylinders are fitted, one at each side of the hopper and with this arrangement each cylinder controls all the doors on one side.

The longitudinal girder (Fig. 5) arched over the hopper was associated invariably with steam driven winches. This traditional arrangement with two winches, one at each end of the hopper girder, has the virtue of simplicity and all that implies in operation and maintenance. A typical hopper gear is illustrated wherein each winch is equipped with three barrels and each barrel is clutch connected to one pair of doors through a system of chains, rods and links. The hopper load is shared amongst the barrels and is actually taken on a stopper bar located in a projecting tooth on each barrel. This stopper is knocked out to release the load. This winch may be driven equally well by an electric motor and one or two successful conversions have been made. The main disability is the relatively high power required in each motor for a duty which, although essential to the vessel, takes place infrequently and is of short duration. The power requirement of the motors may increase the installed generator capacity even when allowance is made for a generous diversity factor.

A modern conception of hopper gear is also shown in Fig. 6, and on this horizontal hopper girder eight hydraulic cylinders control eight pairs of doors. The cylinders are single-acting and hydraulic power is used only to raise the doors on a dual pressure system. A quantity of low pressure oil is passed to each cylinder to raise each pair of doors and a final squeeze is effected by a small quantity of high pressure oil so that the wedge may be secured. For release a high pressure squeeze eases the load on the wedge for extraction and thereafter the doors open under the influence of the weight of spoil. Hydraulic equipment possesses the merits of being positive, simple and economical. The motor power required to drive the hydraulic pump in this design is much less than would be installed in one motor of the traditional winch gear. Individual motor drive in place of a multi-cylinder arrangement has been considered and ruled out because of the high cost involved. The use of hydraulic equipment for hopper operation is rightly expanding but there remains a strong tendency to use a single or twin cylinder system because of the lower capital outlay and to overlook the superior qualities of the multi-cylinder system in service and in maintenance.

A Comparison of Four Hopper Barges

Ship	A.	B.	C.	D.
Length overall, feet	185.5	194	199.6	210
Length B.P., feet	175	185	191	202
Breadth moulded, feet ...	36	34	39	35.5
Depth moulded, feet	15.75	15.5	18	15.75
Mean draft loaded, feet ...	12.6	13.4	15.4	13.25
Speed, knots	10.8	10.3	10.0	11.0
Screws	Single	Single	Twin	Twin
Hopper capacity, cub. ft. ...	20,160	20,000	42,500	24,300
Hopper length, feet	78	60	100	76
Ratio of hopper length/length B.P.	45%	32%	52%	38%
Spoil stowage, cub. ft./ton ...	22.4	20.0	24.4	20.3
Hull weight, tons	464	480	579	600
Machinery weight, tons ...	153	175	106	286
Combined weight, tons ...	617	655	685	886
Hopper deadweight, tons ...	900	1,000	1,773	1,200
Other deadweight, tons ...	32	80	42	—
Water under doors, tons ...	10	11	31	39
Displacement (solid), tons ...	1,559	1,746	2,531	2,125
Propelling engines, type ...	2-stroke diesel	steam triple	4-stroke diesel	steam triple
Propelling engines, B.H.P. ...	620	725	900	1,275
Propeller R.P.M.	250	115	167	130
Method of reversing	direct	direct	through gear box	direct

As usual the aim of the designer of hopper barges is to put the maximum cargo capacity into the minimum hull dimensions having due regard to classification requirements and other governing features. To assist in this aim internal combustion engines in alliance with electric and/or hydraulic equipment offer savings in weight and space of varying degree, depending upon the type of prime mover and auxiliaries adopted. Steam reciprocators have outlived their usefulness and dependability in this service. At the least, new craft should be equipped with diesel machinery running at speeds which will ensure a good and sustained performance with the minimum of specialised attention and cost. The old argument about inexperienced manpower handling elaborate and expensive plant on a dirty job should be — and can be — proved outworn and invalid. Except in capital cost, and even that is doubtful on occasion, an installation having diesel propulsion, diesel-electric auxiliaries in the engine room and on deck and electric-hydraulic hopper gear shows up better than the steamer in fuel, standby and other running costs.

It is shown in the table of hopper barge comparisons that the single screw diesel ship has a slightly shorter but wider hull than the steamer and the important advantage of a lower block coefficient. The hopper volumes are virtually equal although the deadweight is 148 tons less in the diesel ship which with substantially less power and a faster running propeller is a half knot faster than the steamer. The 2-stroke direct reversing machinery

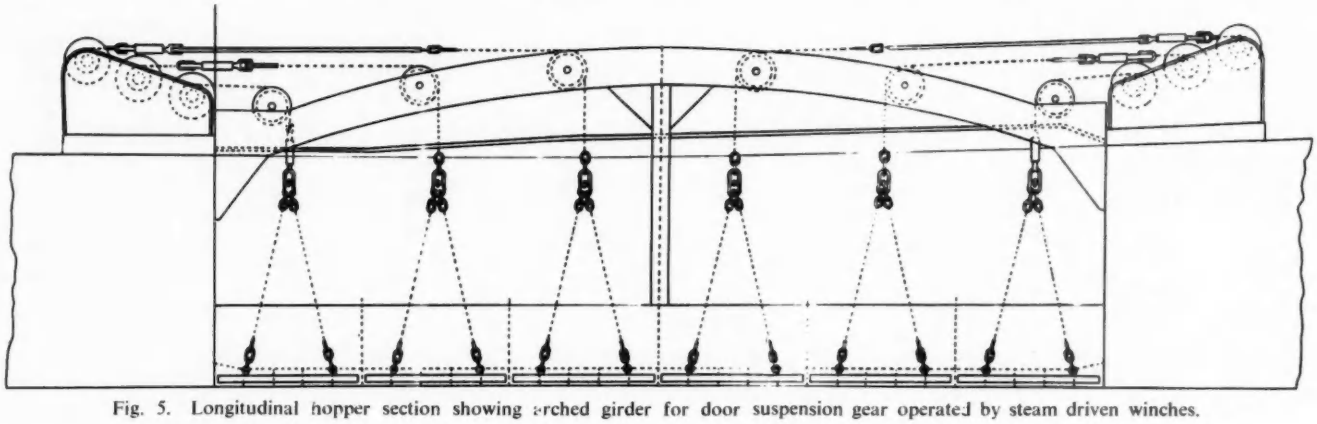


Fig. 5. Longitudinal hopper section showing arched girder for door suspension gear operated by steam driven winches.

Hopper Transport of Dredged Spoil—continued

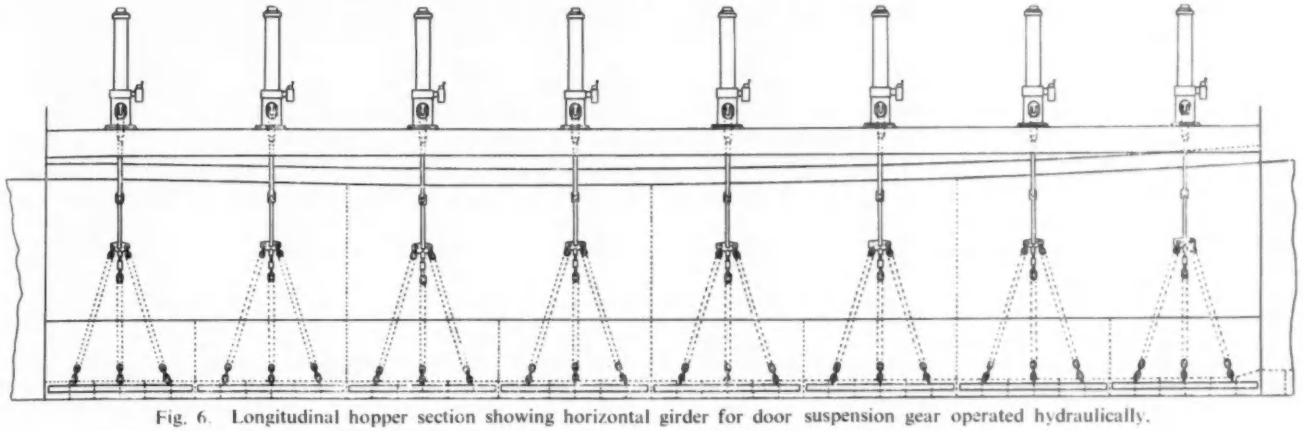


Fig. 6. Longitudinal hopper section showing horizontal girder for door suspension gear operated hydraulically.

apparently offers little in weight saving but the comparison would be much more favourable were it not for the installation being substantially overpowered and thus overweighted by the Owners' requirement. The 5-cylinder main engine was actually capable of developing 850 B.H.P. instead of 620 required for the stated speed. In the twin screw vessels, the combined hull and machinery weight saving of 200 tons is effected predominantly by the diesel machinery which, however, is of much lower power than that installed in the faster steamer. This big diesel carrier with a broader beam, deeper draft and hopper volume 75 per cent. greater than the comparable steamer was made practicable to a large extent by the installation of 4-stroke uni-directional engines driving the propellers through reverse-reduction gear boxes.

The rates of spoil stowage in the hoppers demonstrate the differences which can and do arise in the deadweight carried when working with materials of widely varying densities. It will be observed that in both diesel ships the ratio of hopper length to length B.P. substantially exceeds that of the steamers.

If it is accepted that the criterion of good design in hopper barges is the ability of a barge to carry a large spoil load at a reasonable speed with the minimum of propelling power this comparison clearly shows the superiority of the diesel ship over the steamer. Thus, the expression Barge Ton Miles per B.H.P. is for the single screw vessels 15.7 and 14.2 and for the twin screw vessels 19.7 and 10.4, the higher figure in each class being that for the diesel installation.

The dredging cycle is the time taken by the dredge to load the hopper and the deposit cycle is the propelling time required for travelling to and from the deposit area and the time required to empty the hopper. These cycles should be the primary considerations in determining hull dimensions, hopper capacity and power. Long hauls to dumping site would require more barges to serve one dredge. The hopper should be located as near midships as possible and the slope of the sides, keelsons and transverse members should be arranged with regard to the area and service loading of the hopper doors and to ensure satisfactory dumping of the majority of spoils likely to be handled. A useful modern speed seems to be around 10 knots.

Local river conditions frequently place a limit on length and may make a twin screw vessel desirable for optimum manoeuvrability. The propellers should also be large in diameter and relatively slow turning while the rudders should preferably be larger than for a normal vessel of similar size. However, many hopper barges are fitted with single screws and seem to do quite well even in busy rivers.

The hull dimensions should provide adequate lateral stability and the vessel should be constructed with ample strength and with such proportions as will enable it to operate in rough seas without being too lively. These craft should also be capable of safe navigation between coastal ports and be suitable for ocean voyages by the addition of simple equipment to accord with M.T. requirements. The beam is large compared with a normal cargo carrier and in designing the ship the cargo should be treated as partially liquid. Resulting from this a high G.M. is required and this will probably be around 3—4-ft. in the actual loaded condition.

The light draft is important and must be related for multi-bucket dredge service to the outreach and inclination of the loading chute on lowering and when ready to pass spoil into the hopper. The underside of the chute should clear the aft end of the hopper coaming, the usual starting point, and as the hopper is loaded the barge is moved aft to complete loading at the fore end. The load draft is sometimes a compromise between general serviceability and maximum cargo capacity. With bigger ships requiring deeper waterways there should be no question of restricting the draft of loaded barges unduly.

The standard of accommodation in vessels for this service has risen materially in recent years. In diesel ships it is usually more practicable to arrange the accommodation on the main deck aft instead of, as in many steamers, on the lower deck forward and this accords with good modern practice.

Hudson Bay Report

Record Traffic in 1955

The Fifteenth Report of the Commonwealth Shipping Committee on Hudson Bay Marine Insurance Rates 1956, which describes conditions affecting ships trading to Port Churchill during the 1955 season has recently been published (H.M. Stationery Office, price 1s. nett).

The Report states that during the 1955 season of navigation, 38 vessels made commercial voyages to Churchill, a larger number than ever before and two more than the record created in the 1954 season. Ten vessels made two voyages each and, notably, for the first time on record one vessel made three voyages. The ships loaded cargoes totalling 13,078,000 bushels of grain for discharge in Northern European ports, and two ships included part-cargoes of flour totalling 3,080 tons in their shipments. Four of the ships discharged inward cargo at Churchill.

Although in the 1955 season, the port dealt with a heavier volume of traffic than any earlier year, there was no evidence of delays in shipping turn-round; and the port's shipping statistics for the 1955 season compare favourably with those of the previous year. In 1955, 38 ships loaded 13,078,000 bushels of grain and 3,080 tons of flour (compared with 36 ships and 12,485,000 bushels in 1954). Shipping occupancy of the port totalled 126 days (128 in 1954) and turn-round times averaged 3.3 days for all ships (3.6 in 1954). For five consecutive days in August and for a similar period in September the port was empty of shipping and no commercial vessel used the port after the 10th October.

Navigation Reports.

The reports received from Masters who voyaged to Churchill in the 1955 season have contained a number of suggestions for the improvement of the navigational aids on the route through Hudson

Hudson Bay Report—continued

Strait and Hudson Bay. These suggestions have been brought to the notice of the Canadian authorities, who are continuing in their efforts to make the route as safe as possible for shipping. Again during the 1955 season of navigation, the Canadian Government ice breaker " N. B. McLean " was stationed in the area to advise Masters and to give them assistance if necessary, and other ice breakers engaged in supply duties in those waters were also available.

Before the opening of the 1955 season, and beginning early in July, the Canadian authorities conducted preliminary aerial surveys of ice conditions covering the shipping lanes in the Hudson Bay, between Churchill and Nottingham Island, and other flights were made on a weekly basis until the arrival of the ships. Commencing with the arrival of the first ship, the survey was maintained in the manner considered most suitable to provide information of the ice conditions at the time each ship was in process of transitting the Bay, and, as necessary, ice reconnaissance aircraft were able to communicate by wireless directly with the ships. Ice reports from the aircraft were circulated by Churchill Marine Radio Station and these, together with the reports of local ice conditions made by the Coast Stations along the route, were transmitted to London and circulated to the Shipping Press for publication. From the reports received it is clear that these aerial surveys were a boon to Masters; but there appeared to be a consensus of opinion that the value of the survey would have been enhanced considerably if flights could have been made over the Hudson Strait in addition to those made over the Bay. The Canadian authorities, who will conduct a further aerial survey during the 1956 season, were informed of the comments and suggestions made.

In the last two (Thirteenth and Fourteenth) Reports, reference was made to the analyses made by the National Research Council of Canada of specially-prepared reports on " Radar Detection of Ice at Sea," completed by Masters of vessels trading to Churchill in the seasons under review. Shipowners and Masters using the route in the 1955 season again co-operated with the Canadian authorities by collecting data and furnishing reports about ice formations encountered.

The Council's report, which is the third in a series of annual ice report surveys, deals with data collected by eight merchant ships during eleven voyages to Churchill or twenty-two passages through Hudson Strait. One hundred and twenty-one ice formations were reported of which ninety-two were complete with all radar data, ice dimensions and contours. The first ice was reported by the s.s. " Warkworth " on July 22nd some 300 miles east of Resolution Island and the last report was from the m.v. " La Hacienda " on October 10th in approximately the same region. The Council state that it is significant that practically all ice formations reported east of Long. 64° west were of berg dimensions on which good radar ranges were achieved; an indication that the navigational hazard from drifting ice is low until the approaches to Hudson Strait are reached.

Cargo Handling Facilities.

It has recently been suggested to the Committee that an improvement in the cargo handling facilities in the port of Churchill would help in promoting the carriage of more inward cargoes, and the development of a two-way traffic would encourage more ships to go to Churchill. They brought this suggestion to the notice of the Canadian authorities and invited their views on the possibilities of developing the flow of inward cargoes through Churchill. In reply, they were informed that the transit shed at Churchill, which has a floor area of 82,000 square feet, has been adequate for any import traffic which has yet been offered, although it is possible that in isolated instances enquiries might arise involving lifts for which the equipment would be inadequate; and that it would be difficult to express an opinion on the possibility of improving the inward cargo handling facilities until there was evidence that the volume of inward cargo warranted some improvement.

In the last Report on Hudson Bay, it was indicated that the prospects of developing the shipment of Manitoba and Saskatchewan lumber through Churchill to the United Kingdom would be investigated. The annual production of lumber in Manitoba and Saskatchewan is approximately 60,000,000 and 75,000,000 F.B.M. respectively. According to the latest statistics available, these quantities represent approximately one per cent. in each case, of the total output of Canadian lumber. As a necessary preliminary to the study of this subject the Canadian authorities were consulted about the facilities for handling lumber shipments through Churchill should such a trade develop and they gave the following information:—

(a) No additional railway facilities to the port would be required.
(b) Suitable stevedoring labour might be a problem for casual and intermittent lumber shipments from Churchill (when earlier shipments were made help had to be imported from Winnipeg) but if the trade offered a real potential, stevedoring difficulties would not be allowed to interfere with it.
(c) Any substantial lumber movement at present would almost certainly interfere with grain loadings at the port. This situation would not, however, be allowed to interfere with a potential trade and facilities would almost certainly be installed which would allow timber loading without any interference with wheat loadings.

However, the Commmittee have been unable to discover any demand for lumber shipments between Churchill and United Kingdom ports which could be regarded as indicating a positive development in trade. Militating against a steady demand for lumber shipments are such factors as a strong " local " market in Canada and the United States, and the price to the United Kingdom merchant of lumber shipped via Churchill as compared with similar products imported into the United Kingdom from Scandinavian and other Canadian ports. Whilst existing circumstances continue the chances of timber exports through Churchill developing to any noticeable extent cannot be very highly rated, but the port might well have good possibilities in this connection in the years to come.

During the 1955 season, the planned additional storage accommodation, increasing the grain storage facilities from 2,500,000 to 5,000,000 bushels, was completed. This additional capacity will make it possible to ship up to 20,000,000 bushels of grain through the port each season without any increase in grain galleries, loading berths, etc. The quantity of grain stored at the elevator at the end of the 1955 season amounted to 4,300,000 bushels and it is likely that the elevatoor will be filled to its full workign capacity before navigation begins in 1956.

The report concludes with an additional note by the chairman, stating that an advance copy was forwarded to the Joint Hull Committee in order that the position therein disclosed might be taken into consideration by them when reviewing the position for the forthcoming season. The note states that the Joint Hull Sub-Committee have approved an amendment to the Hudson Bay Scale of Additional Premiums, which provides that, for vessels fitted with gyro compass, the rate shall be 1s. per ton G.R.T. and 5s. 6d. per cent. on the insured value.

Timber Storage Shed at Shoreham

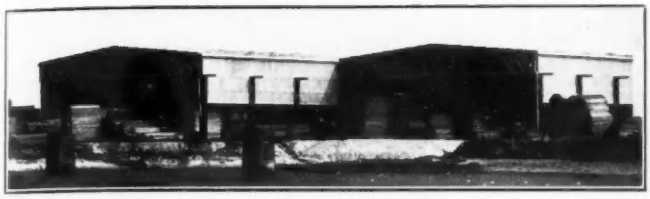
New Method of Construction

A new timber storage shed has recently been erected by Messrs. Beves & Co. Ltd., of Shoreham-by-Sea, Sussex. This building is the third largest storage shed which the company has erected in timber since the war and full advantage has been taken of the experience gained during the construction of the earlier buildings. In this case the open site has made it possible for the functional requirements alone to dictate the design and method of construction.

The requirements which the designers, the Timber Development Association, had to satisfy, were as follows:—

(1) The provision of a maximum unobstructed floor space with a clear height of 25-ft.
(2) Freedom to resite the roadways through the building on either or both axes at any stage after completion.
(3) Freedom to build part of the building initially and extend it subsequently, both longitudinally and laterally, without interference with the original structure.

Timber Storage Shed at Shoreham—continued



View of two of the 106-ft. 8-in. span bays; one bay partially complete.

Modular Co-ordination.

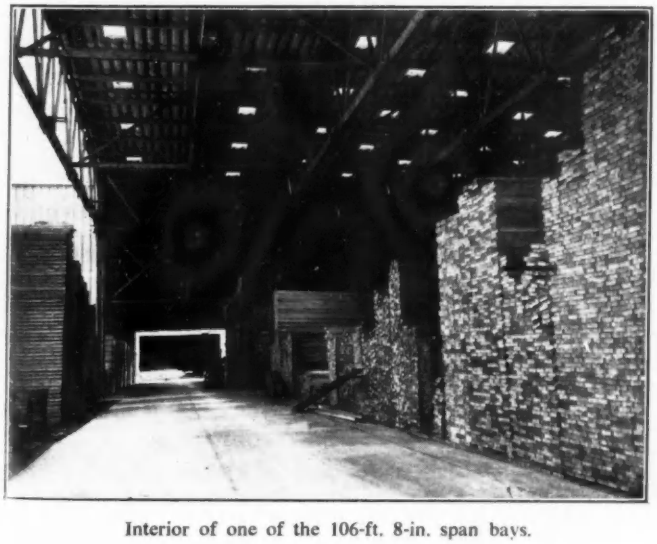
The whole site, including the building itself and the roadways, has been planned on a grid of 3-ft. 4-in. and is in accordance with the current modular co-ordination theory. This theory was introduced in a British Standards Institution Report, published in 1951, which recommended the co-ordination of the dimensions of buildings with the standard sizes of the materials and components of which they are composed. To achieve this, a dimensional unit, the module, is adopted, multiples and sub-multiples of which will give the co-ordination required. In general the Report recommended a horizontal planning module of 3-ft. 4-in. and a vertical module of 8-in. The modules are measured from the centre lines of walls, posts and load points and consequently, an allowance for thickness, etc., has to be made when computing clearances. The common multiples are 6-ft. 8-in., 10-ft., 13-ft. 4-in., 20-ft., 26-ft. 8-in., 33-ft. 4-in., 40-ft., etc.

An additional advantage of modular co-ordination lies in the possibility of securing "reversibility" in the plan, i.e. in arranging that column spacing and other structural features shall be identical along both the length and breadth of the building. By adopting this course, the functional requirements of the building are satisfied in both directions, irrespective of the orientation of the plan and this has obvious advantages. Not only can the axis of the shed follow the most suitable line for the site, but major changes in the layout for the remainder of the site affecting traffic circulation do not create new problems involved in altering the plan of storage.

Details of the New Building.

The section of the new timber shed now completed is only a quarter of the final area. It is intended, during the next few years, to continue construction of the remainder. The finished shed will consist of 4 spans each 106-ft. 8-in. wide and 213-ft. 4-in. long, with a total area of about 91,000 f.s. under cover, having only 24 internal posts, none closer than 26-ft. 8-in. c/c. More steel has been used in the form of brackets, stiffeners, bearers, etc., than in the two earlier buildings and it has been attempted to use timber and steel components where each will be most suitable on their particular merits. The floor is of concrete in order to aid traffic movement and mechanical handling, and to give the maximum flexibility in planning storage.

The fabrication and assembly of the components was carried out on the site after the concrete floor had been laid. Erection was with the aid of mobile cranes, the trusses being lifted into place each as a single unit 106-ft. long, and bolted down to the posts and transom girders. Although planned to meet the requirements of the softwood trade in particular, the design, layout and construction of this new shed could be equally well applied to other industrial buildings requiring wide span, clear floor space and adaptability.



Interior of one of the 106-ft. 8-in. span bays.

Book Reviews

"Pilot—Take Charge." By W. Bartlett-Prince. Published by Brown, Son & Ferguson, Ltd. Price 14s.

The fairly long periods of separation whilst serving afloat in the Merchant Navy become irksome to married officers and when turning their minds to jobs ashore, a pilot's job is usually high on the list. This little book sets out to emphasise the particular nautical subjects on which an officer seeking such an appointment would need to concentrate. Several of the important Pilotage Authorities recruit direct from the ranks of the masters and mates of the Merchant Navy: on the other hand for the youngster who makes up his mind to become a pilot there is still an apprenticeship or similar system at such ports as Liverpool (where they are known as Boat hands), Bristol, Cardiff and Barry.

The title provokes the old argument as to who is responsible when a pilot is on board—the master or the pilot—the author is careful to explain that the master of a ship under pilotage in a British port does not ever relinquish his command to a pilot.

The pages devoted to the alterations and additions to the International Regulations for Preventing Collisions at Sea, which came into force on 1st January, 1954, present the changes in a handy summarised form. Quotations from old judgments are used to illustrate the construction which has been placed on the Rules in a given set of circumstances, but circumstances are seldom alike.

The ommission of any reference to free and compulsory pilotage is no doubt explained by the fact that the defence of compulsory pilotage is no longer available to give shipowners immunity when a pilot, he is obliged to employ, damages his ship. The pilot's liability is limited to £100 even though he be found negligent—his licence and so his livelihood may, however, be taken away by the Pilotage Authority.

Pilotage is essentially a practical subject and only actual experience can produce the sound judgment of a situation and the correct assessment of the capabilities of a ship, it is appropriate therefore that in this book of less than 100 pages the largest chapter, about one-sixth of the total, describes practical methods of shiphandling, where the author is on his own ground.

Pilotage varies widely from one port to another and conditions are seldom the same even in the same place and the wise counsel of an old hand like Captain Prince that—nothing should be taken for granted and that each ship to be piloted is a new task requiring all the pilot's skill and attention—will, if taken to heart help to avoid disasters which flow from over confidence and casual approach to this important job. Its importance has received international publicity recently and this little book is a useful reminder even to qualified masters who decide to become pilots.

Although the introduction of ship-borne radar has been fairly widespread since the war, few pilots will be found to enthuse over its value. There have probably been many occasions, however, when the P.P.I. has provided that confirmation of a ship's position which the pilot has been eagerly searching for.

The idea that radar in its present stage of development renders the employment of a pilot unnecessary will not stand close examination—but the full appreciation of its value would undoubtedly improve if pilots received some instruction in radar navigation.

The author has perhaps wisely refrained from any comment on the introduction of electronic equipment to assist the navigation, but the views of experienced pilots are nevertheless awaited with considerable interest. R. W.

Book Reviews – continued

"Inland Waterways and Inland Ports" ("Binnenwasserstrassen und Binnenhafen") by Dr-Ing. Heinrich Press. 500 pp. and 520 illustrations. Published by Wilhelm Ernst & Sohn, Hohnzollerndamm 169, Berlin-Wilmersdorf. Price 58.50 Dm.

The author of this comprehensive volume is professor of the Technical University of Berlin-Charlottenburg. The work is of great practical value and importance and shows extensive experience of the subject: the major part revolves about the German practice and one can safely say that exceedingly little has been omitted. In place of division into chapters the author has used a decimal grouping of 120 sub-headings: there are no less than 427 references in the bibliography which is sufficient evidence of the precision and patience that has been given to the subject.

The large number of illustrations are mostly line drawings of constructional details and lay-outs of equipment which cannot but be of great assistance to Students and Designers.

A Handbook on Belt Conveyor Design; 150 pp. Crown Octavo, 70 line illustrations, 40 tables and charts. Published by the General Electric Company, Ltd. Price 30s.

This latest addition to a series of handbooks compiled by the technical staff, materials handling department, of Fraser and Chalmers Engineering Works (General Electric Co. Ltd.) in association with Hewitt-Robins Inc., New York, includes complete details of basic design and will be of service to all engineers engaged in the design and application of conveyor systems.

Variations of straightforward conveyor belts, such as conveyor type feeders, trippers, etc., are dealt with at length, and a feature of value for design offices is a chapter on Fundamental Analysis of Conveyors.

A sample calculation for conveyors, together with the description of how the details are worked out, links the various sections of the text. The final section of the book comprises a series of tables and charts providing ready reference to all data required for conveyor calculations.

A publication of this kind is of value not only to those engaged in conveyor design, but to students, trainees and to engineers contemplating a conveyor installation. Whilst not unique as a reference work, the half-century of design experience embodied in the text ensures its authority.

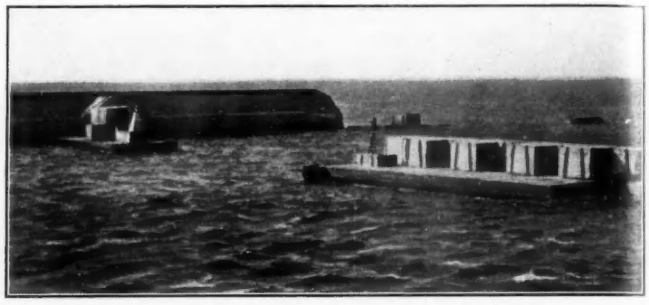
"The Port of Genoa, 1955" ("Il Porto di Genova nel 1955") in Italian, with supplement (explanatory) in English. 135+50 pp. 9½-in. x 11½-in. Published and edited by the Consorzio Autonomo del Porto di Genova.

This annual of the Port Authority of Genoa, just published, is well produced and replete with details of the port's activities, including folding plans and maps, coloured photographs, diagrams and tables of traffic, imports and exports, labour output and extensive information of port details: projects, equipment and services.

It will be recalled that in the early part of last year (19/2/55) the port of Genoa was subjected to a tremendous gale which caused severe damage in the harbour and to the protecting breakwater, which was breached in several places, the most serious being that adjacent to the West entrance. It is as well to remember that the series of breakwaters defending this port have an overall length of over three miles in the open sea, and are sited in depths of water from 66 to 100-ft. They enclose a deep water area of 815 acres. After the storm a temporary western entrance was rapidly constructed by partially closing the channel between the end of the standing outer wall and the Canepa Pier; this succeeded in protecting the Sampierdarena basins.

At the time of the calamity fears were held that there would be a serious setback to the trade of the port. However, the present publication shows the prognostication was wrong: as a matter of fact the turn-round of shipping during the year 1955 was greater than ever: 4.5 per cent. increase of shipping, and 19.1 per cent. increase of merchandise. These figures represent an increase of 60.9 per cent. on the pre-war average (1928—1938); which is highly creditable to this autonomous port.

In the Spring of 1954 the works of construction of the Genoa-Sestri Airport was commenced under the aegis of the Genoa Port Authority. It is built out 1,000 metres from the shore in 60-ft. depth of water, like an enormous breakwater, in front of the Ship-



Temporary new western entrance between damaged breakwaters and Canepa pier, Genoa.

building yards of Ansaldo at East Sestri. Already 25 per cent. of the wide shore arm rubble fill has been completed and the prospects are that the airport will be in service by 1960. The runway is 2,000 metres long and lies on a mole 300 metres wide.

R. R. M.

Ford's Industrial Demonstration

Wide Range of Mechanical Handling Exhibits

The Ford Motor Company Ltd. recently held an industrial tractor demonstration at Dagenham, at which some 40 firms exhibited over 60 machines. Representatives from many branches of industry and members of foreign trade delegations visited the site and all showed keen interest in the display.

The main object of the demonstration was to give a new concept of mobile industrial equipment. Most of the machines displayed have been developed for work in and around factories and for use on civil engineering and building projects, and are designed to bulk handle materials in the most economical way. All of them are powered by the Fordson Major industrial unit.

Ford pioneered mechanisation in the field of agriculture, and have applied their design experience to the problems of industrial and civil engineering concerns, many of which are similar to those of agriculture. Farm mechanisation depends almost entirely on the tractor as a mobile power plant around which special machines have been developed for specific jobs in addition to its normal function of towing trailers, ploughing and drilling. The basic characteristics of this power unit can be equally well used in machines which are specifically developed for industrial purposes. The Tractor Division of Ford Motor Co. Ltd. have co-operated with some 45 equipment manufacturers, all specialists in their own fields, in the utilisation of the tractor or tractor power unit, and the result has been the development of an extensive range of machines for a wide variety of industrial purposes. These include pipe laying machines, bull dozers, scrapers, loaders, shunters, cranes, compressors, generators and many others.

Below are brief descriptions of some of the exhibits which are of particular interest to readers of this Jonrnal.

Messrs. Chaseside Engineering Co. Ltd., of Hertford, showed a fork-lift conversion unit which transforms their "Loadmaster 600" shovel into a fork-lift truck capable of lifting 3,000 lbs. The load can be lifted to a maximum height of 10-ft. in seven seconds and returned to floor level in five seconds. The maximum width of the outside of the forks is 4-ft. and the minimum width 1-ft. 10¼-in. The unit is available with standard or heavy duty clutch.

Messrs Pratt of Sutton, Surrey, added interest to the demonstration when a helicopter was landed on the site to enable their tractor, the Sutton Tritor to display its capabilities. This tractor is designed for two main jobs, aircraft towing and operating in confined spaces in hangars, and as a general handyman for factory, dockside and shunting duties. The low overall height and ability to turn in its own length plus its great pulling power make it an extremely versatile machine.

Ford's Industrial Demonstration—continued

Messrs. Stothert & Pitt Ltd., of Bath, demonstrated a towed type roller for compacting granular materials. Known as the Vibroll 72T, it has a roll 6-ft. wide and 4-ft. 3-in. diameter, the vibrator of which is powered by a Ford Diesel Engine. It is hauled by a tractor and the vibrator clutch is controlled by the driver. The machine weighs 3¾ tons and is fitted with retractable spring loaded scrapers and an inching jack to facilitate coupling up to the tractor. The degree of compaction obtained by this type of machine exceeds that of a dead weight roller of many times its own weight.

Messrs. F. Taylor & Sons (Manchester) Ltd., of Salford, Pendleton, Lancs., had two cranes on show. The first, the Jumbo 3 ton Slewing Crane, is of the articulated canti-lever jib type mounted on a ball-bearing slewing ring which is virtually frictionless, and the slewing motion extends through approximately 220 degrees. The nose jib, which can be raised and lowered separately from the main jib, is fitted with two hooks. The three ton hook is in a fixed position at a radius of 10-ft. 8½-in., whilst the two ton hook is mounted on a special roller mounted carriage which can be propelled forwards and backwards by means of a hydraulic ram within the jib. This has a range of 4-ft., which enables loads to be positioned with great accuracy when stacking. Both hooks are protected by hydraulic overload devices by which the machine will not accept a load greater than its correct rating in any position. The ratings are:—

3 tons at 10-ft. 8½-in. radius and maximum height of 14-ft. 6-in.
2 tons at 12-ft. 2½-in. radius and maximum height of 15-ft. 10-in.
22 cwt. at 16-ft. 2½-in. radius and maximum height of 19-ft. 1½-in.

Because all four road wheels are mounted on high duty semi-elliptic springs and have servo-assisted hydraulic brakes of large diameter, and the front wheel steering is of the hydraulic booster assisted type, the machine is easily handled at the maximum legal road speed of 20 m.p.h.

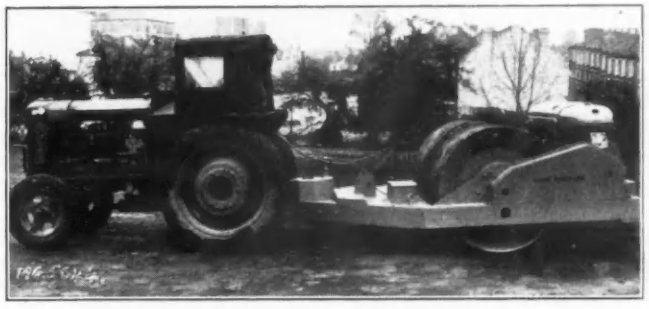
The second crane, the Jumbo Junior Grabbing Crane, was designed for loading and unloading broken material of various kinds. It is highly manoeuvrable by virtue of the rear wheel steering and can operate under restricted headroom if required. Both the jib, which is of cantilever construction, and the grab, are hydraulically operated, and the machine is capable of handling up to 150 tons per day.

Messrs. Atlas Copco (Great Britain) Ltd., of Wembley, Middlesex, demonstrated a portable two-stage, two cylinder compressor of the single acting type with an air cooled finned tubular intercooler. This compressor gives an output of 110 cubic ft. per minute of free air at 100 lbs. per sq. in. for operating two tools, and is powered by a Ford 954E diesel industrial engine which is coupled to it through a "Twiflex" automatic centrifugal clutch, allowing the engine to be started independently. Among other exhibits from this firm were a new plug and rock drill weighing 20 lbs., the Atlas Copco MT505 air hoist and the new LPC 41 high lift pump and LPC 21 sump pump, both fitted with air filters and suction strainers.

Messrs. Broom & Wade Ltd., of High Wycombe, Bucks, were another firm to demonstrate compressors, as well as a wide range of pneumatic tools. The compressor shown was a rotary portable two-stage with an output of 120 cu. ft. of free air per minute at 100 lbs. pressure. It is mounted on two pneumatic tyred wheels with full trailer equipment and 12 volt electric starting gear is incorporated.

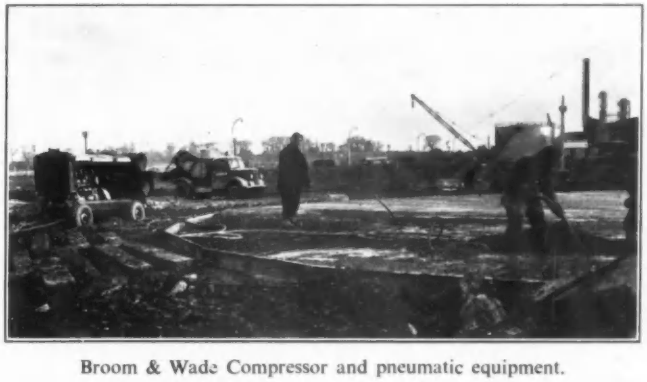
The pneumatic tools exhibited included an air operated link chain hoist capable of lifting half a ton at a rate of 20-ft. per minute and weighing 52 lbs., a heavy duty pneumatic breaker delivering 1050 blows per minute, and an air-operated hand drill weighing only 7½ lbs.

The Merton Engineering Co. Ltd., of Feltham, Middlesex, exhibited two overloaders. The first, the Merton Overloader Mark V, loads in a straight line from the stockpile direct to a truck or dumper, thereby eliminating the necessity for turning or slewing. It can be fitted with a standard bucket of ¾ yd. capacity, or a light materials bucket of 1 cu. yd. capacity, both buckets being wider than the overall width of the front wheels. The machine has a loading rate of 120 to 150 tons per hour, a safe working load of one ton and a discharge height ranging from 6-ft. 11-in. to



Stothert & Pitt Vibroll 72T.

F. Taylor & Sons Jumbo 3 Ton Slewing Crane



Broom & Wade Compressor and pneumatic equipment.

Atlas Copco "One-Ten" Portable Compressor.

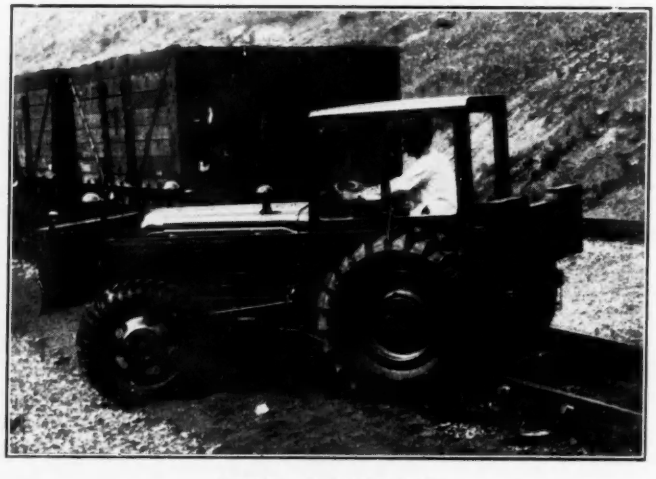
Ford's Industrial Demonstration—continued

Merton Overhead Loader.

11-ft. 2-in., and the complete cycle of operation from loading the bucket, tipping and returning to the loading position, is 15 seconds.

The Merton Two-Way Loader is a hydraulic loading shovel which can be fitted with either $\frac{7}{8}$ cu. yd. or $1\frac{1}{4}$ cu. yd. buckets discharging at either the front or rear. The rear discharge is fully controlled and can be varied in height between 4-ft. 10-in. and 9-ft., thus reducing wear and tear on the vehicle being loaded. The bucket also has a considerable outreach at the rear—1-ft. 11-in. at a discharge height of 9-ft. and 3-ft. at a discharge height of 5-ft. The front discharge is variable from ground level to 9-ft., at which height the outreach is 4-ft. 7-in. The bucket is automatically kept horizontal while travelling over the machine, its movements being actuated by two pairs of double-acting hydraulic rams controlled by a twin lever multi unit self-centring type valve. The machine has a loading rate of 100 to 120 tons per hour and a loading cycle of 24 seconds.

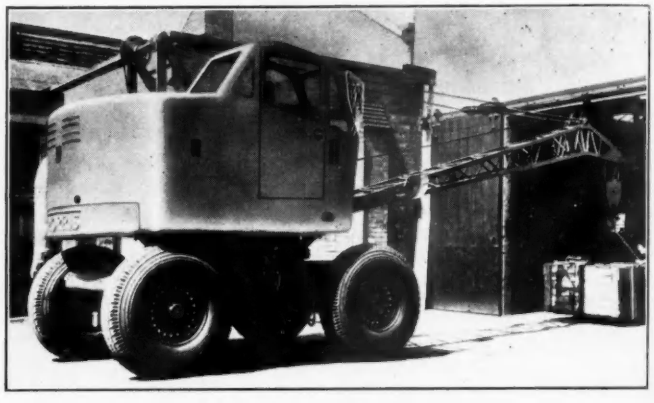
Messrs. F. E. Weatherill Ltd., of Welwyn Garden City, Herts, exhibited the diesel powered "Epping Auto-Shunter," which is capable of shunting loads of more than 150 tons on straight level rail. The freely pivotting front axle, specially chosen tyres and application when necessary of the "Steering brakes," enables the machine to climb over high rails and points even from unfavourable angles of approach. Adequate ballast over the driving axle provides high tractive efficiency, whilst the Differential can also be locked to overcome wheel-spin, enabling maximum loads to be moved even when operating on bad ground. With a fuel consumption of only half a gallon per hour, the "Epping Auto-Shunter" provides a cheap means of dealing with many shunting problems, and the company has received orders from the British Transport Commission and the Port of London Authority, as well as an interesting order from the Ministry of Supply for a flame-proofed version of the machine for the War Office.



"Epping Auto-Shunter."

Messrs. Herbert Morris Ltd., of Loughborough, Leices., displayed a crane capable of slewing full circle in either direction and able to travel with the rated load suspended at any point within the slewing circle. The crane, known as the M120, is self-propelled by either a Ford high-speed, radiator-cooled diesel engine or a Ford petrol engine. An engine-driven generator provides current for the four motors operating the hoist, slew, derrick and travel motions, and operating speeds are regulated by the accelerator pedal. Speeds up to $7\frac{1}{2}$ m.p.h. unladen and 3 m.p.h. laden are attained on level ground.

The swan-neck jib is 21-ft. between centres, constructed of rolled steel sections, and designed to give ample clearance for bulky loads with the jib at minimum radius. Depending on the load, the radius of the crane varies from 10-ft. to 22-ft., the height of lift from 20-ft. 9-in. to 10-ft., and the reach below ground level from 27-ft. 3-in. to 38-ft. The crane weighs approximately 13 tons.



Morris M120 Mobile Crane.

Messrs. Steels Engineering Products Ltd., of Sunderland, showed the Model S.710C Coles mobile crane. This is a full circle slewing petrol electric crane fitted with a 20-ft. cantilever jib with a 10-ft. bolt on extension, giving a total length of 30-ft. The bolted on extension gives height of lift when required and when removed, allows the crane to be used under restricted headroom. With the 20-ft. jib, the crane has a rated lifting capacity of 6 tons at 8-ft. to 2 tons at 20-ft. radius, and with the 30-ft. jib, 6 tons also at 8-ft. and 1 ton at 30-ft. radius.

Future Developments by Ford's.

The site chosen for the demonstration is surrounded by evidence of the biggest expansion programme in the British motor industry in which Ford will have invested over £65 million in the next five years Alongside the demonstration area the new foundry building is under construction. This building, when completed in April next, will cover an area of 260,000 sq. ft. and will have cost over £5 million. It will be the most modern of its kind in Europe.

Other Ford developments include the modernisation of the Leamington factory, completion of a unified stores depot covering 362,000 sq. ft. at Aveley, commencement of work at the new town of Basildon to increase component production facilities, and the construction of a new site at Dagenham.

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